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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

Institution of British Foundrymen.

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Forthcoming Events.

Institution of British Foundrymen.

Lancashire Branch.—"Foundry Accounts, Costs and Statistics," by R. Dunkerley, on February 4.
London and District Branch.—"Sand Blasting," by E. L. Samson, on February 9.
Birmingham Branch.—"On the Trail of the Brass Foundry Imp," Chap. MDCCCI., by D. Whyte, on February 11.
Scottish Branch.—"The Smelting of Pig-iron," by — Anderson, on February 11, in Glasgow.
Burnley Section.—"Oil Sand Cores, Methods and Mixtures," by J. Masters, on February 9. Annual dinner on February 11.
Falkirk Section.—"Malleable Cast Iron," by H. Williamson, on February 18.
Sheffield Branch.—"Cupola Facts, Factors and Fancies," by A. Poole. Joint meeting of the Derby and Sheffield Branches, and visits to some Sheffield works, on February 18.
Coventry Branch.—"Properties of Centrifugal Castings," by G. Williams, on February 22.

A Suggested Wedding Present for Princess Mary.

It has recently been stated that the moulder of 200 years ago probably possessed greater skill than his present-day descendant. We consider that the present time is opportune to test foundry skill by offering to Princess Mary two castings, one of artistic merit and the other of domestic utility, on the occasion of her marriage. A suitable committee of expert foundrymen and artists will be appointed to judge the merit of the castings which we ask the whole of the British foundry trade to submit.

Rules to be followed.

We suggest that the following rules should be adhered to as far as possible:—

(1) The casting to be either of domestic utility or ornament.

(2) To be sand-moulded from cast iron, steel, bronze, brass or aluminium, and to weigh not more than 10 lbs., except in the case of aluminium, where it is limited to 5 lbs.

(3) Machining to be kept down to a minimum.

(4) Lacquering, coating, or treating the surface by any process other than polishing, is not allowed before inspection by the committee.

(5) Firms or individuals may submit samples, but in the case of the former the names of all the employés who have taken part in its production must be given.

(6) A short descriptive note should accompany each sample.

(7) A selection of the castings submitted will be exhibited at the International Foundry Trades' Exhibition on THE FOUNDRY TRADE JOURNAL'S stand.

(8) The casting will be judged by a committee representing both art and foundry skill.

(9) Samples should reach this office before February 27, being sent by registered post or delivered by hand. A receipt will be given for each, and after the exhibition the castings will be returned to the senders, except those selected by the Committee as being suitable for offering to Her Royal Highness.

(10) To the casting there will be affixed a suitable inscription.

Points in Judging.

In the judging of the samples, skill in workmanship will be of primary importance, especially in the case of the casting of domestic utility. Additionally, the metal from which the casting is made will be taken into consideration; for instance, it is obviously more difficult to produce a delicate casting from steel than from a high phosphorus cast iron.

Unless in the opinion of the Committee the highest skill and workmanship is shown, no casting will be offered to Princess Mary.

It will be interesting to ascertain whether there has been a real decline in moulding skill or whether it is just after-the-war pessimism. We will not offer an opinion, but will await the judgment of the artistic and foundry worlds.

FOUNDRY FILMS.—Mr. Thos Vickers, C.E., of Central House, New Street, Birmingham, who is acting on behalf of the Technical Advisory Committee of the International Foundry Trades Exhibition, will be pleased to hear from firms possessing films dealing with foundry or allied work.

The Fluidity of Molten Metals.

At a meeting of the Sheffield Branch of the Institute of British Foundrymen held on December 3, Dr. C. H. Desch, D.Sc., Ph.D., of Sheffield University, gave an interesting lecture on the above subject. In the course of his remarks, Dr. Desch said when the subject of the fluidity of molten metals was looked into it was very striking that on this, as on many other foundry problems, so very little information existed in a published form. Fluidity was a thing of very great importance to every foundryman, who had, of course, a very clear notion of what it meant, and how it was controlled, but very little scientific, organised knowledge of fluidity existed. By fluidity they understood the property that metals had of flowing freely, and so of filling readily the cavity of a mould. Anything which diminished the fluidity of a metal made it more difficult to fill a mould completely. The sharpness of castings depended on other factors as well as fluidity—the amount of expansion that took place at the moment of setting, for example, affected the sharpness very greatly, but fluidity was one of the factors governing that result. The net effect, which the foundryman called the fluidity of his metal, was really the resultant of a number of different factors. To make a test of fluidity in the foundry, the method adopted was a simple, empirical one. They simply made a mould, of such a form that it would reveal differences in fluidity between different metals, and that was most easily done by using as the mould a cavity made by embedding a long, narrow pattern. If a wooden rod a foot long and of small section was taken, a sand mould made with the aid of that pattern, and provided with a pouring gate and riser, then, on pouring metal into the mould, a fluid metal might fill it completely, a metal which was less fluid would fill it to a smaller extent, and a metal which was very little fluid would give only quite a short casting. That was, of course, an empirical test, which measured what the foundryman wanted to know—the power that the metal had of filling the mould. But that was not a simple property in itself. Mr. Riddel, a former president of the Institution, was in the habit of using, in Glasgow, a wedge-shaped mould, starting with a fairly thick mass and gradually tapering away to a knife edge. He used that in the course of work on semi-steel to determine the fluidity of various semi-steel mixtures, and he was kind enough to give some of the results to the Royal Technical College, Glasgow, while the lecturer was there, and they were in use in the foundry teaching. Undoubtedly, foundry teaching in Glasgow owed much to the work of Mr. Riddel, who had built up in the Technical College excellent foundry classes, and was always ready to give help when required to all those who were concerned in the foundry industry.

Some Japanese Experiments.

The amount of work that had been done on fluidity from a quantitative point of view—that was, work directed towards getting values for fluidity which could be expressed in figures—was very small. One piece of work was simply an extension of the simple empirical foundry method of which he had spoken. Some two years ago two Japanese workers at the University of Kyoto undertook a research on the fluidity of metals. Instead of using a simple, straight rod as pattern for making the mould, they used a spiral of the type shown in plan and section, Figs. 1 and 2 respectively, in order to show up in a still more striking way the differences in fluidity between samples of different metals. The mould was provided with a pouring gate, and a riser at the centre. The pattern was embedded in sand, so as to make a mould into which the metal could run. A very fluid metal would be able to fill the whole of the narrow channel, right as far as the riser at the centre; a metal which had very little fluidity would only be able to fill part perhaps of the outer turn of the spiral, and intermediate metals would fill an intermediate length. These workers purposely chose a very long pattern in order to be able to reveal great differences in fluidity. As a matter of fact, none of their metals ever filled more than three turns. The mould was made of fine sand, very carefully dried and then brought to a certain definite temperature, the same in all the experiments. The melted metal was poured into the receiver, and when the receiver was full an iron stopper was raised and the metal allowed to flow downwards and to fill as much of the mould as it could. The quantity used was large in comparison with the capacity of the mould, so that there was always a large excess of metal and a relatively constant head. The investigators found great differences between different metals. The results were shown by photographing the castings

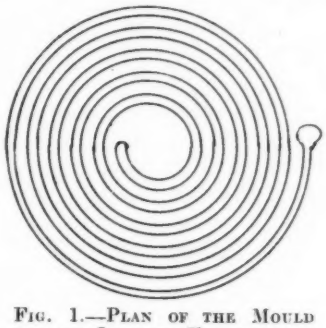


FIG. 1.—PLAN OF THE MOULD FOR THE JAPANESE EXPERIMENTS.

that were taken out and measuring their length, and, of course, the length of the castings was an indication of the fluidity of the metal. In every case the temperature of the metal at the moment of casting was taken—*i.e.*, the temperature when it was in the receiver and the feeding head—and the degree of superheat (the excess of temperature above the melting point of the metal) was recorded. They therefore had these factors: the degree of superheat, the temperature of the mould (which was kept as constant as possible), and the length of the casting; and so one obtained an indication of the fluidity of the metal.

Viscosity.

Now actually such a method as that measured what the foundryman wanted to know: the capacity for filling the mould; but that was not a simple property, but was the resultant of several different properties. There was a property which was known scientifically as fluidity. If they compared together different substances which were not metals, they soon noticed the difference in

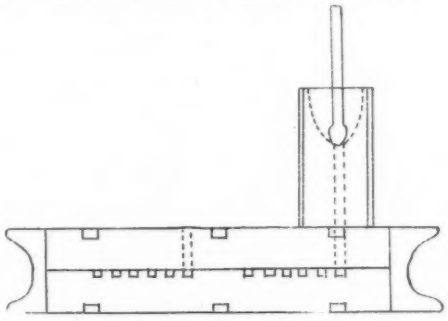


FIG. 2.—SECTION OF THE MOULD SHOWN IN FIG. 1.

fluidity, the difference in the ease with which they flowed. Ether, for example, flowed more readily than water; water flowed more readily than glycerine, and glycerine more readily than treacle. And so they spoke of the order of fluidity of the metals, or very often they spoke, instead, of the order of viscosity, which was opposed to the order of fluidity. Ether had a very low viscosity indeed, treacle a very high one; and so one might go on to other substances which became more and more viscous until one scarcely thought of them as liquid at all.

Pitch—A Liquid.

One did not ordinarily think of pitch as being a liquid. It was a liquid, only an extraordinarily viscous one, and it would flow if only they gave it time. If they hung up a rod of pitch by the upper end, in course of time it would flow; it would

gather into the form of a drop, and at last the drop would break off, just as would happen with water if they allowed a drop to hang from the ceiling. But the order of viscosity was altogether different. The flow which took place in a fraction of a second in water might require several months in the case of pitch.

Testing of Viscosity.

The opposite of viscosity—usually expressed as the reciprocal of viscosity—was fluidity. Viscosity was a very important property of many substances, and they often had to test it in the laboratory. For example, if they were testing lubricating oil, they would want to know its viscosity in the course of routine laboratory tests, and the easiest method of determining it was by allowing the liquid to flow through a narrow opening. Suppose they had a vessel containing liquid and in the lower part of this vessel they fixed a narrow tube of known diameter, then they opened the end of the tube and allowed the liquid to flow through it, and noted with a stop watch the time that was required for a definite volume of the liquid to flow through. That was very easily done with apparatus which was sold for the purpose, usually called a viscosimeter. The more viscous the liquid was the longer was the time taken for a given volume to flow through. That was an accurate method. If they knew the diameter of the narrow tube, if they knew the density of the liquid, they could calculate its viscosity quantitatively.

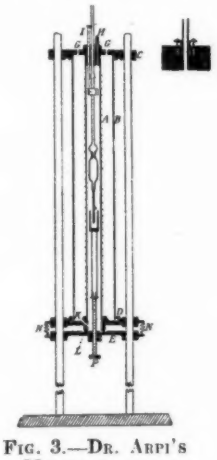


FIG. 3.—DR. ARPI'S METHOD OF DETERMINING THE VISCOSITY OF METALS.

Dr. Arpi's Method.

It was not a very easy matter to apply that method to metals, and, in fact, it had not been found practicable yet to apply it to cast iron or steel; but to metals which had relatively low melting points it could be applied, and that work was done with great accuracy a few years ago in Sweden by Dr. Arpi. The apparatus shown in Fig. 3 was rather a delicate one, but the essential part was a small receiver at the top, made of graphite, and connected with it was a long tube of fused silica which had bulbs blown on to it and ended in a very narrow tube, dipping into a little crucible made of graphite. This portion of the apparatus was enclosed in an electric furnace, which could be kept at any required constant temperature. There was an arrangement by which gases could be admitted. The great difficulty with metals was their oxidation, and in order to prevent this one had to keep an atmosphere of hydrogen or something similar in the vessel; and, in fact, in the actual experiments, hydrogen saturated with a vapour of methyl alcohol was used. The best method of carrying out the test was to place the molten metal in the little graphite crucible, and then, instead of allowing the liquid to run down by gravity, to draw it up by suction, and to find the time that was required for the liquid to rise from a certain mark to another mark. The time was noted, and that gave an accurate measure of viscosity. This apparatus having been very carefully constructed, it was possible to get quite accurate values for the true fluidity or the true viscosity of the metal, free from all interference by oxide films. The temperature, of course, was too high for glass, and the vessel had to be made of fused quartz. The method gave some very accurate results indeed.

Coil of Wire Method.

There was also another method for determining the viscosity of metals. Suppose they had a wire hung from a support and to the end of that wire they attached a weight in the form of a flat disc—a heavy weight, so that it would stretch the wire—and then they turned the disc through a considerable angle (perhaps through several turns) and released it. Of course, the wire untwisted, and the disc spun round. It overshot the mark and turned back again, and went on oscillating in that rest. If they carried that experiment out in air they found that it took a certain time to come to rest. If they turned it through the same angle, but with the disc in a vessel of water, they found that it came to rest sooner because the water offered a certain resistance or friction. If they carried out the same experiment in glycerine of course it came to rest sooner, and in that way they could measure the viscosity of the liquid. It was an accurate method, once one or two little sources of error had been eliminated, and it was a very convenient one. That also had been applied to metals. Dr. Fawsitt, in Glasgow, some years ago, made experiments of that kind, using a cast-iron disc for metals of low melting-point and a disc made of plumbago for higher temperatures. Obviously in the case of the plumbago there had to be a weight hung on the wire as well, to make the plumbago sink in the metal.

Results Obtained.

The results of the Japanese experiments were expressed in length of casting obtained in the spiral mould. Tin proved to be the most fluid of the metals; lead gave a casting very nearly as long, and zinc something very near to it. Then there was a series of bronzes, one containing 20 per cent. of tin and 1 per cent. of zinc, and another 10 per cent. of tin and 2 per cent. of zinc. The percentage of tin being so much lower in the latter, the fluidity was very much reduced. Aluminium gave a very short casting, the fluidity of that metal being very low. Then there were some cast irons. Two grey irons were used—a Cleveland iron, which gave a longer casting than even tin. It was true that it had 140 deg. C. of superheat, but it gave a casting 3,250 mm. long—over 10 ft. A Chinese iron gave 2,822 mm. White iron gave the shortest casting of all—433 mm., only half as much as was obtained even with aluminium. Then a crucible steel was taken of a 0.4 per cent. carbon with 200 deg. C. superheat, and it gave 1,100 mm. This method, therefore, was found to be practicable for metals even of high melting-point. It did not measure fluidity in the scientific sense, but it measured what the foundryman wanted to know—the capacity for filling a mould.

The results obtained by Dr. Fawsitt's method of spinning a heavy disc were expressed in a figure known as the coefficient of viscosity. The measurements were taken at temperatures from 65 up to 215 deg. C. As the temperature rose, so the coefficient of viscosity became less, *i.e.*, the metal was more fluid. The higher the temperature the more fluid was the metal—that was the case for all liquids, with a few exceptions in the cases of abnormal substances, such as sulphur. Tin, at a temperature of 234 deg. C., which was only two degrees above its melting-point, had a viscosity about twice that of mercury, which was liquid at the ordinary temperature. At a higher temperature for the tin, that value had fallen. Lead, just above its melting point, was more viscous than tin; it also fell at a higher temperature. Bismuth had a low viscosity. That point was interesting. It was sometimes thought that metals were rather sluggish—watching a molten metal flowing, it seemed to be rather sluggish; but, when it came to measuring the true viscosity, it was found that most metals were only from two to three times as viscous as water. That was a rather unexpected result, but there seemed to be no doubt about it. Of course, that did not mean that they would fill a mould as readily as water.

Viscosity and Superheat.

If they compared together the different metals, they found that at any given temperature the order of viscosity was roughly the same as the order of the melting point. The higher the melting point of a metal the more viscous it was at a given temperature. In other words—and this was the point that interested the foundryman—the greater the amount of superheat the greater was the fluidity. Taking a metal melting at 200 deg. and testing it at a temperature of 500 deg., which was 300 deg. of superheat, then, at the same temperature of 500 deg., testing a metal which melted at 400 deg., and which had therefore only 100 deg. of superheat, it would naturally be expected that the latter would be more viscous or less fluid than the other.

Curves obtained for the more fusible metals by

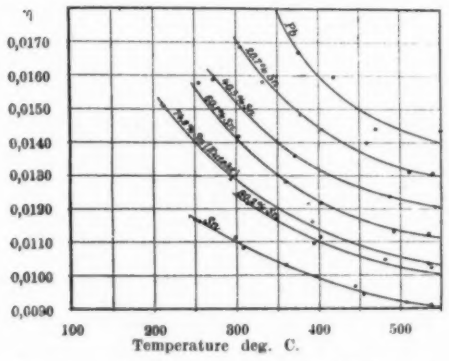


Fig. 4.—Viscosity of Lead-Tin Alloys as Measured by Dr. Arpi's Method.

Arpi's method were free from error. Different temperatures from 100 deg. C. to 500 deg. C. were plotted along the diagram, while vertically was plotted the coefficient of viscosity. Lead, which had a certain coefficient of viscosity, just above its melting point, 327 deg. C., fell pretty regularly with increasing temperature. The viscosity of tin was much lower, but that viscosity also fell with the temperature. If alloys of lead and tin were taken (the ordinary solders) and similar experiments made with them, it was found that in every case the viscosity fell with rising temperature along a curve very similar to the curves for lead and iron, and those curves for

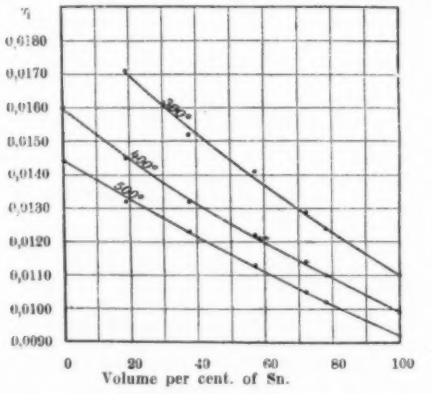


Fig. 5.—Viscosity-Temperature Curve of Tin-Lead Alloys.

the alloys of lead and tin all fell pretty regularly between the curves for lead and for tin (Fig. 4). Solder containing three parts of tin to one of lead had the lowest melting point of all the solders. In Fig. 5 the results for the alloys were plotted in a different way and showed that the alloy which was mostly lead and contained only a little tin has a certain viscosity, and the alloys containing more tin had successively lower and lower viscosities. So that there was complete regularity in alloys of this kind, and everything seemed to show that if two metals were alloyed together, provided that they did not form compounds with one another, then the fluidity of the alloy would come between the fluidities of the two metals.

The Complexity of Fluidity.

Fluidity, as understood by the foundryman, was not quite a simple thing. There were certain other factors that entered into it. Evidently one important factor was the true fluidity or the viscosity which he had been showing was measured in those different ways. But that was not the only one. If it were, then a metal like molten bismuth, which had a fluidity very little greater than water, ought to fill a mould with very great ease. But, of course, they had other properties to consider. In the first place, as the metal was going into the mould it was cooling. It was giving up its heat, and in time it would reach the freezing point, and when it reached the freezing point it ceased to flow into the mould. Evidently, therefore, the rate at which the metal gave up its heat would be an important factor. The specific heat of the metal came into consideration—that was a factor that affected the mould-filling properties. Then still more important was the degree of superheat. The hotter the metal was—that was, the higher the temperature above its melting point—the further it could go before it cooled down to the freezing point; so that, naturally, if they had to fill a complex mould having a large number of narrow portions, they required the metal sufficiently hot so that it should not freeze too soon. The degree of superheat was of immense importance.

Strength of Aluminium Oxide.

And then there was, with many metals, a certain apparent or false viscosity which was very striking. One would be inclined to say that aluminium was a particularly viscous metal. It gave, as they had seen from the Japanese results, quite short castings. The danger of getting a cold shut in a casting was great with such a metal as aluminium, and on watching aluminium being poured one would naturally get the impression that it was a viscous metal with very low fluidity. Now that was not actually true. Everything seemed to show that the metal aluminium was not really more viscous or not much more viscous than other metals. But, of course, aluminium had a remarkable property of oxidising readily, and, unlike most metals, the film of oxide that was formed on the outside had most remarkable strength. There was a very striking experiment which was sometimes shown. If an electric current was passed through a wire or a thin rod of aluminium and increased until the metal melted, the metal would not break through. It was possible to take one end of that wire and twist it through 100 revolutions or more without breaking it, although the wire of aluminium was actually liquid. This was because it was coated on the outside with a thin skin of oxide of aluminium, and that skin was so strong that it formed a bag which would suspend the metal. It was quite remarkable to take a little mass of aluminium and heat it up to a temperature which would not only melt it but would be hot enough to set it on fire, and yet as long as this bag of oxide on the outside remained unbroken the liquid metal would not escape, and would not catch fire. The apparent viscosity of aluminium was due to this skin. As the metal was being poured in a stream through the air that stream became enclosed in a thin tube of oxide which had the effect of viscosity, just as some liquids when they were in thin films had all the properties of being viscous. It was really only a thin skin that was concerned. That, he thought, was the main reason why aluminium tended to give these very short castings. The same thing, of course, was seen in other metals, although probably in no metal was it so striking as in aluminium or in magnesium.

(To be continued.)

PREVENTION OF CORROSION. — The Institute of Metals has just issued a practical pamphlet of 32 pages, giving in summary form the results of over ten years' research into the causes and prevention of corrosion in condenser tubes. The pamphlet, which is one that will appeal particularly to all engineers, can be obtained, price 2s. 8d., post free, from the Institute of Metals, 14, Members' Mansions, Victoria Street, London, S.W.1.

XUM

Keighley Laboratories, Limited.

Internal Chill in Grey Iron Castings.

It will not be denied that so far as the foundry is concerned much has still to be done to bring our system of working and methods of production into line with the best Continental practice. The main contributory factor to this undesirable condition has undoubtedly been the persistent refusal of a large percentage of manufacturers to recognise the operation of a foundry as a scientific proposition; thus, until comparatively a few years ago haphazard methods were the rule rather than in addition to meeting the everyday requirements of their works. The general foundry must be content with a very much more modest equipment, which will provide for ordinary analysis but offers no facilities for research, whilst for the greater percentage, which come within the category of "small foundries," the laboratory and chemist are commercially impossible, and the foundry manager, who is also the foundry foreman, has to carry out the duties of foundry chemist.

THE CHEMICAL LABORATORY.—KEIGHLEY LABORATORIES, LIMITED.

THE BALANCE ROOM.—KEIGHLEY LABORATORIES, LIMITED.

the exception, and mixtures were determined by "judgment."

Happily, however, these conditions will soon be relics of the past; in the large foundry they have already gone by the board, and a laboratory is now regarded as an essential auxiliary to the modern foundry of any pretensions.

Naturally, the fitting up of an efficiently equipped laboratory in a works entails very heavy overhead charges, which can only be sustained by such manufacturers who are in a position to engage their laboratory staff upon research work.

Obviously it is the small foundry which is the most heavily handicapped. The ideal arrangement is no doubt the employment of a chemist, whose duty it is to attend to the scientific side of the foundry operations, and who would work in sympathy and close co-operation with the foundry manager.

The Formation of the Laboratory.

The origin of the above Company was the result of lectures given in 1918-1919 by Mr. W. H. Poole, of Bradford. He was then asked to address the members of the National Employers'

Federations (Keighley and District) on December 3, 1919. The matter was then fully discussed, and it was unanimously decided that a private limited company should be formed by the engineering firms in the Keighley and District Association.

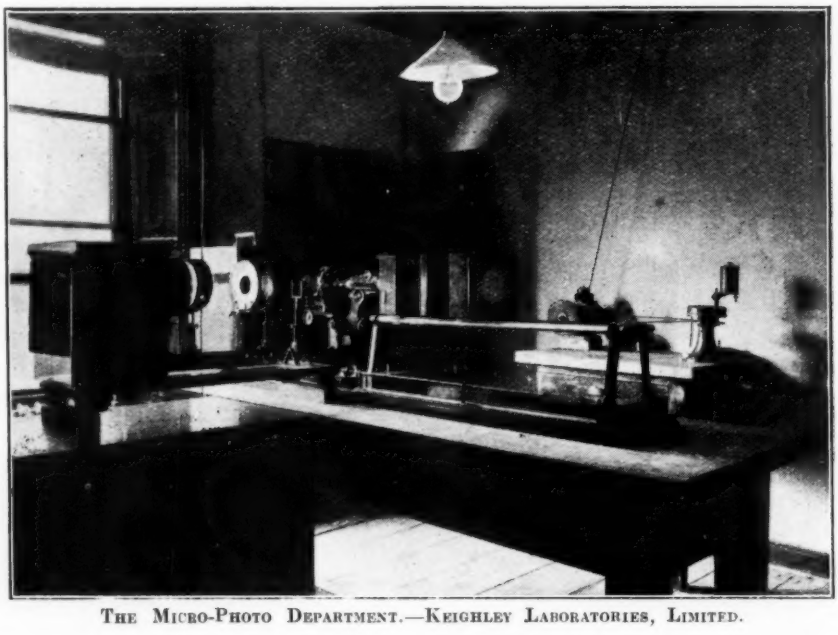
A committee was formed to draw up a concrete and workable scheme, and consists of the following gentlemen:—Sir Harry Smith, K.B.E., and Messrs. Gifford Smith, John Stell, David Waterhouse, T. Alborn Clapham, A.M.I.M.E., Walter Slingsby, M.I.M.E., and Richard Carrick. Mr. Walter Slingsby was elected chairman, Mr. R. Hudson secretary, and Mr. W. H. Poole was appointed managing director. It was, however, recognised that to promote the best interests of the industry the laboratory must be run as an entirely independent undertaking. The directors of the company controlling its financial workings, but not having access to the results obtained for any individual firm. Shareholders and non-shareholders have exactly the same services as regards work undertaken, the shareholders having the benefit ultimately when the business is a paying proposition.

The main aim of the Company is to apply practically in the shops the results of testing work done, and it is only in this way that the best results can be obtained. A most important point is that the small firms have a service equally as efficient as the large concerns, at charges which compare very favourably with similar establishments; indeed, where contract work is undertaken, the cost is reduced to a sound commercial basis, whilst, needless to say, the results of any work done are strictly the private property of the firm concerned.

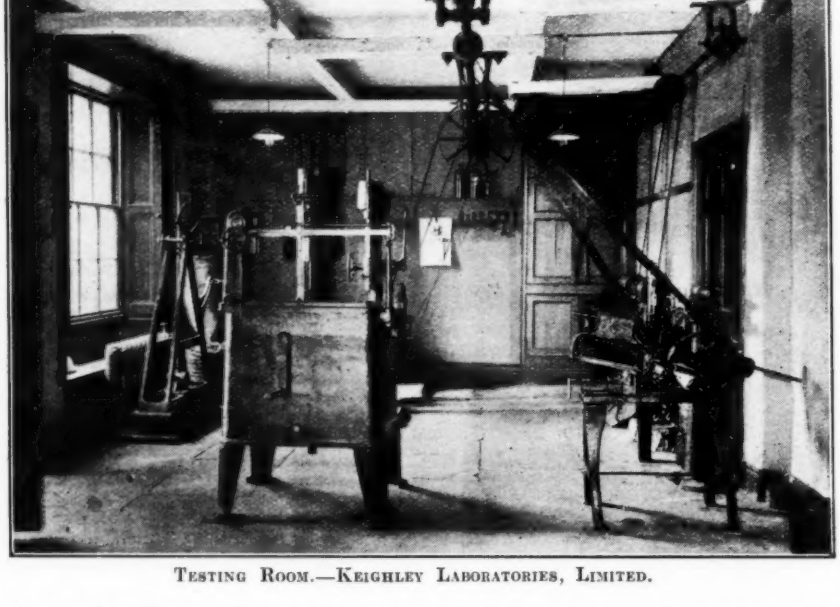
Equipment of the Laboratories.

The Company were fortunate enough to purchase the late private residence known as "Croft House," in South Street, Keighley, which was eminently suitable for conversion into laboratory premises, and, with slight structural alterations, provided for balance room, chemical laboratory, microscopic plant, and dark room, sampling department, store room, physical laboratory and machine shop, case-hardening heat-treatment shop, offices and library.

The chemical laboratory, fitted with the necessary benches, provides ample floor space for the accommodation of six chemists, whilst provision has been made for doubling the present capacity. The laboratory is well equipped with the necessary apparatus for work in connection with



THE MICRO-PHOTO DEPARTMENT.—KEIGHLEY LABORATORIES, LIMITED.



TESTING ROOM.—KEIGHLEY LABORATORIES, LIMITED.

foundry and general engineering testing, which, so far, has included mainly pig-irons, sands, refractories, water analysis, gas analysis, coals, cokes, oils, liquid fuels, etc.

The balance room contains accurate balances, combustion apparatus, electric furnaces, etc.

The micro room is equipped with a Watson microscopic set. There is also apparatus for making lantern slides and enlargements, a branch of work which is now being fully developed.

With regard to the testing laboratory and machine shop, this section still awaits equipment with various machines, though the plant at present installed is sufficient to cope with general routine work.

The case-hardening shop is equipped with gas-fired furnaces and high-speed tool-treating furnace with the necessary quenching media. In this shop experimental case-hardening is conducted, and also routine case-hardening work is undertaken for the trade.

For the present the company undertake to search for any technical information required, and at a later date it is hoped to have an efficient library and technical bureau, which will be available to clients of the company.

Internally-chilled Castings.

Amongst the interesting work recently undertaken by the Keighley laboratories is research work in connection with internal chill in grey iron castings, and by the courtesy of Mr. W. H. Poole, we are able to publish the conclusions arrived at from these investigations.

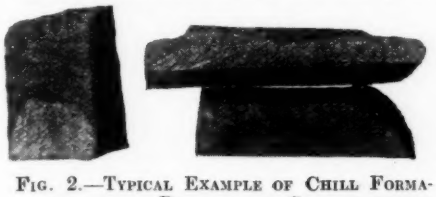


FIG. 2.—TYPICAL EXAMPLE OF CHILL FORMATION AT THE BASE OF THE CASTING SHOWN AT THE RIGHT, AND (LEFT) A FORMATION IN A PULLEY CASTING—THE GREY PORTION ADJOINS THE HEAVIER HUB SECTION.

Of the many perplexing problems that have been investigated in connection with foundry practice few have been so astonishing and interesting as internally chilled grey iron castings. The phenomenon is of such interest that the data cannot but prove helpful to foundrymen generally, and Mr. Poole's kindness in sanctioning the publication will be as generally appreciated.

In general, the attitude of the foundry in connection with such peculiar phenomena does not tend to get to the basic causes of the faults, as, after a time, such matters come and go, being corrected by some means not fully understood. It is in the complete investigation of such problems that laboratory work should be of such vital assistance to foundrymen.

It may be noted that there have been no less than a dozen cases in the Keighley district where this fault has been found, very often in foundries where a totally different class of product is made. Mr. Poole refrains from expressing a searching theoretical explanation of the cause of internal chill, pointing out that much lengthy research in the laboratory and foundry is required to establish a more convincing solution than has already appeared.

Particulars of Working Conditions.—In order

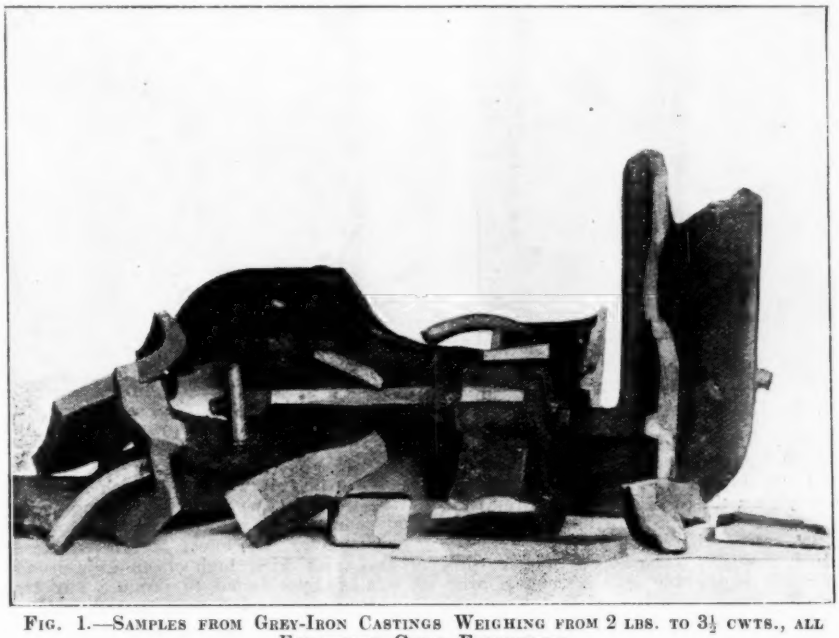


FIG. 1.—SAMPLES FROM GREY-IRON CASTINGS WEIGHING FROM 2 LBS. TO 3½ CWTS., ALL EXHIBITING CHILL FORMATIONS.

to give an idea of the analyses of the pig-irons and scrap used, a typical example from the laboratory's experience is quoted.

	Pig-iron Analysis			Scrap
	A	B	C	
	Per cent.	Per cent.	Per cent.	Per cent.
Silicon	3.80	2.75	3.90	2.40
Sulphur ..	.046	.023	.02	.15
Phosphorus ..	1.07	1.70	1.71	1.40
Manganese ..	.45	.49	.41	.41

In the first place, it will be noted that the pig-irons "A" and "C" are very silicious irons, and give an example of the type that has been sold during the last 12 months as No. 3 foundry pig. In each case it will be seen that the manganese content averages less than 0.5 per cent. With regard to the scrap, it is important to note the high sulphur and low manganese contents, the above analysis being an average over a considerable number of samples from the scrap pile.

As it would be difficult to incorporate data of the cupola conditions over the many cases examined, the following brief notes are made to cover this item generally.

Cupola Condition.

The phenomena have been observed from cupolas showing various melting conditions, especially with reference to tuyere area ratio to furnace diameter. The furnaces under examination showing as much variation in the ratio between furnace area and tuyere area as 1 : 3½ to 1 : 15.

The conditions noted in the various furnaces convince Mr. Poole of the necessity of more standardisation of furnace working.

The bulk of the furnaces under examination showed that the air supplied to the furnace exceeded, if anything, the normal volume required

for efficient melting, but, with the exception of one or two cases, the volume could not be considered very excessive.

Sulphur in Coke.

What is perhaps the most important point is the question of the coke in use, as this matter has a very important bearing on the whole subject.

The average analysis of coke used gave the following figures:—Ash, 9.9 per cent.; and sulphur,

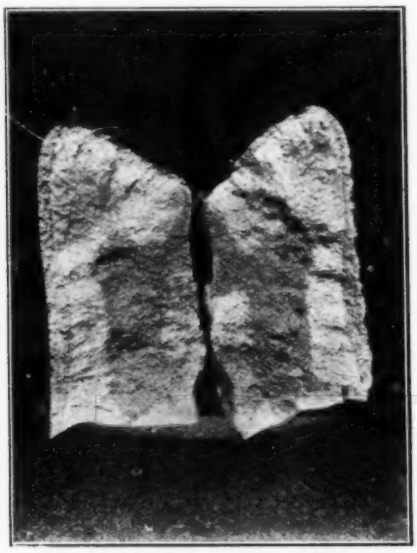


Fig. 3.—Example of Chill Formation.

1.15 per cent. The sulphur content of some samples of coke exceeded 1.25 per cent., and in no case did the sulphur show below 1.0 per cent. Generally speaking, the coke was of a hard nature, and gave hot metal. There are few foundrymen who have not had much trouble recently with the coke question, and it is to be hoped that the production of really high-grade coke for cupola practice will shortly be a regular matter. Examination of very many brands of coke show that recent supplies are very much higher in sulphur than pre-war coke, the average figure over ten to

Fig. 4.—Example of Chill Formations.—Note the White Core to the Down Gate.

twenty brands being higher than 1 per cent. sulphur, against an average 0.75 per cent. pre-war.

Character of Castings.

Our illustrations have been made from various sections of castings showing this internal chill and range from 1¼ in. down to ⅜ in. section in castings weighing ½ lb. up to 4 cwts. The position of the chilled portion is of great interest, in some cases the chilled iron being in the bottom of the casting, whilst in a further example the gate itself shows an interesting chill formation.

All the samples noted were cast in green-sand moulds, and careful investigation of the condition of such moulds has proved conclusively that with normal metal a wide variation of mould condition, such as damp and hard rammed moulds, etc., this peculiar chill is not produced.

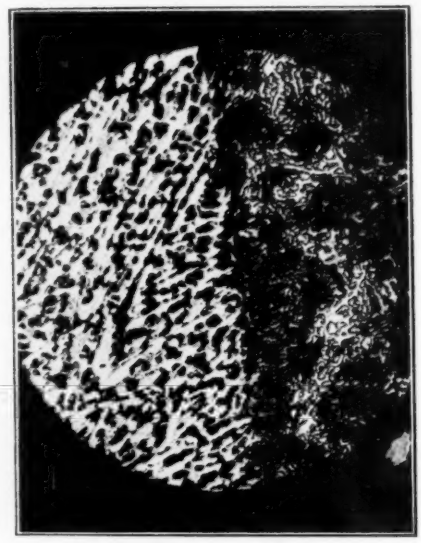


Fig. 5.—Micro-Section at the Junction of the White and Grey Formations.

Experiments were made with a view to producing the chill formation by varying the mould conditions and using ordinary grey iron metal, with no success. The effect of damp ladles, etc., was also tried with high-silicon grey iron of normal analysis, yet failed to produce any trace of the phenomenon under consideration.

Casting Conditions.

As will be noted later, the bulk of the examples under consideration were made from the first

Fig. 6.—Micro of White Section showing that the Carbon is mainly Combined in this Section.

metal down the furnace, extending in some cases to the first half-ton or 15-cwts. tap. Contrary to what would be expected, the temperature of the metal in most cases was high enough to run thin-sectioned castings.

An explanation of the high sulphur-content of the metal as analysed is simple, as the sulphur

absorption from the bed by the first metal down is quite well understood by foundrymen. However, it has been proved that similar trouble can be experienced with metal cast later on in the blow, an example of this being quoted later.

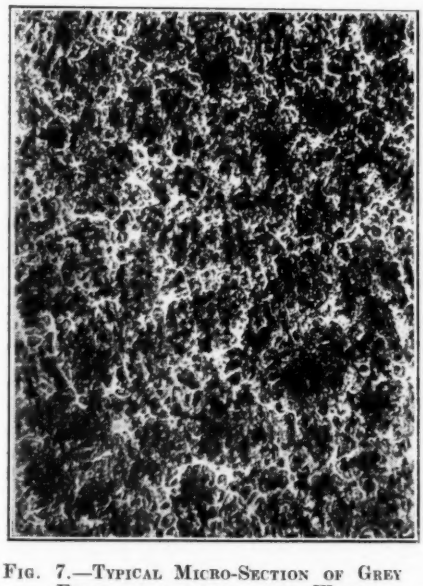


FIG. 7.—TYPICAL MICRO-SECTION OF GREY FRACTURE ADJOINING THE WHITE.

Analysis of the Metal.

Grey Portion.

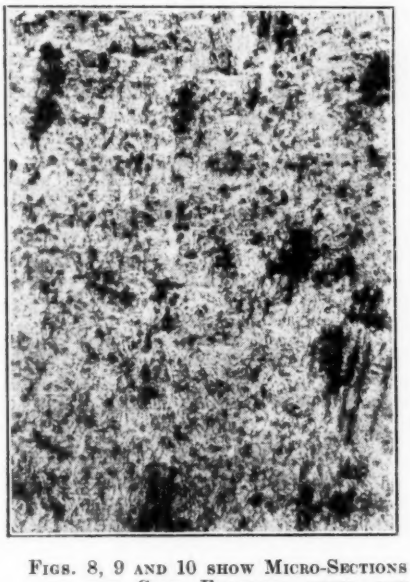
	T.C.	C.C.	Si.	S.	P.	Mn.
1.	2.94	0.81	2.45	0.17	1.48	0.26
2.	2.94	0.95	2.42	0.24	1.55	0.26
3.	2.77	0.90	2.99	0.25	1.53	0.24

White Portion.

	T.C.	C.C.	Si.	S.	P.	Mn.
1.	2.94	—	2.40	0.202	1.45	0.25
2.	2.92	2.80	2.30	0.234	1.57	0.25
3.	2.77	—	2.79	0 236	1.49	0.25

Analysis shows the silicon content of the samples to be 2.4 to 3 per cent., the sulphur contents being distinctly high. In conjunction with this it is important to note the low manganese content of the cast iron—in every case under examination the amout of manganese found being less than 0.35 per cent. As far as the metal is concerned, it is this peculiar combination of high silicon and sulphur with low manganese that has a most important bearing on the formation of the internal chill. Concession will be taken that this phenomenon is usually found in high silicon iron in combination with high sulphur and low manganese. Mr. Poole has examined many samples of much lower silicon iron containing high sulphur and low manganese, but with 2 per cent. of silicon and below an entirely white or mottled fracture is produced. Previously published data of German origin states that the occurrence of the chilled portion is due to the formation of iron sulphide in the absence of sufficient manganese to combine with the high sulphur present, as indicated by the Baumann sulphur pressure test; but Mr. Poole finds that the cases under notice by no means confirm the suggestion that owing to the relatively low melting point of iron sulphide, the segregation of this metalloid will be at the centre of the section.

The above investigation was conducted previous to the report mentioned, and it is interesting to note that Mr. Poole has successfully overcome this trouble by increasing the manganese content in the mixture to approximately 0.8 per cent.



FIGS. 8, 9 AND 10 SHOW MICRO-SECTIONS OF THE GREY FRACTURE FROM THE WHITE TO THE OUTSIDE.

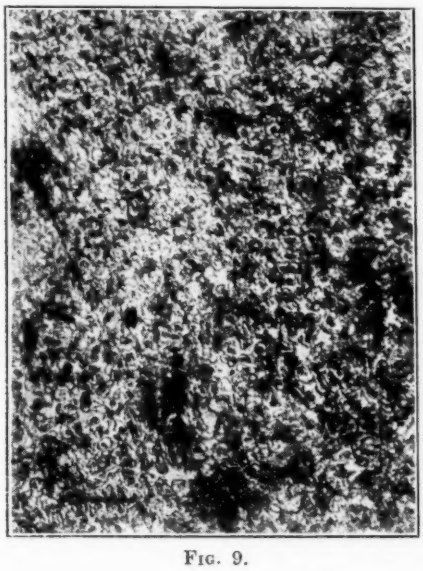


FIG. 9.

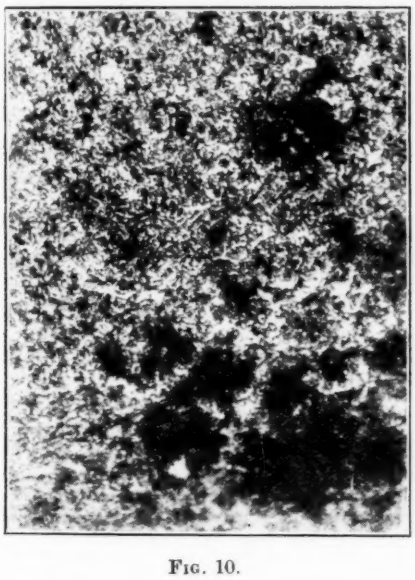


FIG. 10.

Mr. Poole is in complete agreement with the theory put forward that the high sulphur content in the absence of sufficient manganese does form iron sulphide which is sufficiently powerful in the presence of the ordinary percentage of silicon to prevent the separation of graphite. Whilst admitting this, he is compelled to express the opinion

that other factors are plainly conducive to this phenomenon, for the analysis shows that the sulphur content is equally as high in the grey portion as in the white with the same percentage of manganese

The chilling effect of the mould and the fact of quick or slow cooling in various sections and position of the casting materially affects the results obtained. No doubt the influence of the pressure and cooling conditions of the mould vastly affect the particular formation of this chill at any spot. It is the cooling condition of the mould which Mr. Poole considers influences the formation of the mottled appearance of the fracture. In some of the chilled portions, by means of the microscope, several nodules of graphitic carbon were evident, but these were widely separated. At the present time, investigations are being put forward with reference to various cupola conditions, quality of coke, temperature of melting, etc., with a view to obtaining fuller information.

Precautions Necessary.

The most important point to note is that this fault can be entirely overcome if the following precautions are taken. As sulphur and manganese play a very important part in the formation of this chill effect, it is necessary first to use coke with as low a sulphur content as possible, and to ensure that the metal stock contains sufficient manganese to allow a final percentage of at least over 0.5 per cent. in the cast iron. The first metal down obviously does not get the same temperature reaction as later metal, and this very materially affects the final result. It is most important to eliminate tapping small charges from the cupola. The practice of melting and tapping out 1 cwt. or so of metal at a time and expecting a good mixture of iron has been proved fatal. It is advisable to collect sufficient metal in the well of the furnace for the first tap to ensure thorough mixing. It is very important to keep the coke bed at the correct height and to eliminate any oxidising tendency. The addition of pre-heated ferro-manganese in the ladle has been tried and proved successful, but obviously this is not the correct way of maintaining the manganese percentage in the mix.

To sum up the precautions necessary:—

1. The metal mixture must have an average content as regards manganese of approximately 0.75 per cent. minimum. The use of at least one brand of pig-iron containing high manganese (1 to 1½ per cent.) being sufficient to give this addition.
2. To obtain coke as low as possible in sulphur.
3. To ascertain that the coke bed is well burnt-through before charging commences.
4. To avoid a low coke bed.
5. To avoid taking small quantities of metal first from the cupola making a practice of collecting a good supply in the well of the furnace to ensure thorough mixing and to attain a suitable temperature in the cupola.

The white portion of the castings examined was so hard that it was almost impossible to drill samples from same for analysis, and in some cases we have not been able to obtain any drillings on this account. It is the difficulty in obtaining samples from these castings that prevents more chemical data being obtained.

A casting was made from a period about half way through the blow from a mixture for medium heavy grey iron work. A sample of tooth wheel shows a maximum thickness of 2 in. with teeth approximately ¾ in. An analysis of the broken wheel gives the following results:—Combined carbon, 1.14; silicon, 2.07; sulphur, 0.31; phosphorus, 1.09; and manganese, 0.32 per cent.

The fracture of this casting showed a very peculiar mottled grain in the thick section and white on the teeth edge. There were patches of white fracture near the outside edge of the casting, and this case is quoted to show an analysis very similar to those showing internal chill, but with a lower silicon content. The fault in this case was traced to very high sulphur scrap, and at the same time the use of low manganese in the mix. The casting could only be sampled with great difficulty and by the use of a special tool.

In conclusion, it is only by careful attention to details of melting practice that such troubles can be overcome. Whilst by no means advocating the use of poor stock, it is very important in these days to pay every attention to the details of working of any cupola and any cost of analysis of materials is well repaid in the final results obtained.

It is the practical application of data obtained from the laboratory which proves a very valuable asset to the foundry, and the above notes show the value of laboratory work applied in practice. It may be stated that every case of the formation of this internal chill has been corrected by attention to details as above.

Advantages of High Carbon in Weldless Steel Tubing.

In a Paper read by MR. W. W. HACKETT, at a joint meeting of the Institution of Automobile Engineers and the Birmingham Metallurgical Society, recently held at the Birmingham Chamber of Commerce, the matter of chief interest from the metallurgical point of view was the author's account of experiments conducted with high- and low-carbon steels. Experiments on aeroplane tubing during the war showed that excellent results could be obtained by using 0.5 per cent. carbon steel tubing giving in the bright or blue state a yield of 40 to 45 tons per sq. in., and an ultimate stress of 45 to 50 tons per sq. in. In the motor trade there was a disinclination to use these high-carbon steel tubes, which it was thought would necessarily be brittle. No extra care had been used in heat treatment, but the result of hundreds of tests carried out showed that 0.3 per cent. carbon was always better than 0.15 per cent., and 0.5 invariably superior to 0.3 per cent. Details were given of a number of these tests. In one series 20-gauge tubing made of 0.54 per cent. carbon steel had practically as long a life under the same weight and shocks as 17-gauge tubing manufactured of 0.338 per cent. carbon steel. Figures were given showing the greater strength of high-carbon than of medium- and low-carbon steels. One experiment showed that a 20-gauge high-carbon steel was practically as strong as a 15-gauge low-carbon steel, though only half as thick. This was attributed to the fact that after undergoing the brazing process the elastic limit of a 0.5 per cent. carbon steel was about twice as high as that of a 0.15 per cent. carbon steel at the brazed joint, and consequently the high-carbon steel was able to stand much more stress than the low-carbon. It was also concluded that the high-carbon quality had twice the life of a low-carbon when subjected to the same fatigue.

In the course of a discussion which followed MR. A. E. TUCKER called attention to the fact that silicon had a great effect upon the mechanical properties because of its influence on carbon, and it should always be taken into account in connection with the carbon content.

Patent Abstract.

Particulars of Complete Specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of 27, Chancery Lane, W.C.2, and Commerce Chambers, Parliament Street, Nottingham.

Printed copies of the Specifications in the following list are now on sale.

147,470. ROBERTSON, F. D. S. Process of and apparatus for obtaining volatilisable metal oxides.

172,693. WICHMANN, T. H. Manufacture of compositions of metals or alloys and graphite.

172,720 REID, J Furnace fronts.

172,746. WHITE, A. E Metal shelvings.

152,667. RHEINISCH-NASSAUISCHE BERGWERKS AND HUTTEN, AKT.-GES. Mechanical roasting and calcining furnaces.

156,644. KOPPERS, H. Method of and apparatus for operating cupola furnaces.

THE SOCIETE METALLURGIQUE DE SAMBRE ET MOSELLE have secured an order for 40,000 to 45,000 tons of steel rails and accessories from the Argentine State Railways.

Foundry Organisation for Costs and Records.

By P. C. Critchlow.

(*Continued from page* 68.)

Wages Control.

The monthly analyses of wages for works and staff is agreed with the wages book total, and actually the analysis sheets become transfer vouchers to the costs ledger. Wages control account is opened in the costs ledger, which carries the amount of the wages cheque. A separate account is opened for each section of production, maintenance, or general service, in accordance with the standing order numbers. The total wages expenditure in each is entered to the debit of its own account. The total production wages in all departments and sections equals the sum of all the wages on each order as shown on the cost cards.

The maintenance and general services having been analysed and charged to the departments for which the work was done, the various oncost accounts are credited and the production departments are debited. When all direct transfers are made to production, any items unallocated are transferred to general oncost and general oncost is cleared, as will be explained later.

When the direct charges are entered against the production accounts, the percentages to direct wages as already posted will give shop or departmental oncost.

Stores Control.

In large foundries it is frequently necessary to have more than one store and to give each a distinguishing letter or number. All deliveries to stores are controlled by the "material inwards sheets," shown in Fig. 11. These give the particular store to which the goods were supplied. The purchase journal in columnar form shows the debits to each of these stores.

The stores control accounts are for each store and are debited with the amount transferred from the purchase journal. Debits to finished work stores will also include work from the shops on "returned to stores notes." This will cover any parts of castings that have to be fitted later into an assembled article. The total debits from both sources will be supplied by the monthly analysis sheet. A stores ledger card (Fig. 12) is written up for each type of pig-iron, metal, scrap iron, and castings in the rough stores or finished work, and for each class and type of general supplies, tools, or other commodity in the stores. The bin number is the identity number and also stores ledger number. This number appears on all "material inwards slips" and stores requisitions, so that identity of goods is assured. The "material inwards slip," after leaving the accounts office, bears the value of the goods as passed for payment on the invoice, and entered in the purchase journal. This amount becomes the debit on stores ledger accounts.

The purchases are entered in detail to the stores ledger card and total purchases for the month are posted to the stores control in the costs ledger. The requisitions on stores are forwarded daily or weekly to the costs office. These are sorted to classification of goods, and each classification is dissected to standing order number and department. This forms the materials analysis for the month. On the stores ledger cards issues are credited, and the departments drawing the material are shown. These stores credits become debits to costs and are charged against that department which used the material.

FINANCE DEPT. COPY.

MATERIAL INWARDS SLIP. No.....Store.....

Supplier.....Advice Note No.....Date.....192

No. of cases Received	Case No.	Description of Consignment.

Goods Accepted.

Order No.	Description.	Stores Reference.	Quantity.	Weight. T. C. Q. Lb.	Rate	Amount	Amount	Invoice No.	Stores Ledger Reference.	Cost Allocation

Rejected.

Date received by Storekeeper.....

FIG. 11.—THREE COPIES OF THIS FORM ARE MADE AND SENT TO THE STORES, FINANCE AND PURCHASE DEPARTMENTS.

The value of productive material issued as shown on ledger cards is transferred to metal and melting account or to job cost cards, as already described.

The oncost material, tools, maintenance, and shop supplies, etc., are charged to the departments in the costs ledger in the same manner as wages, and transferred to production departments as an element of oncost, as has been explained in detail.

The total issues are posted to the stores control accounts, and the balance should represent stock in stores. The stores control accounts thus represent the sum of the whole stores ledger cards. A continuous stock-taking is in progress, and bin cards are checked against physical stock and stores ledger balances. Stores ledger balances and costs accounts are linked up to the control accounts.

In cases where the goods go direct to shops, a separate column in the journal is used, and the shop or section taking the goods is stated on the "material inwards slip." This at the end of the month is written off to costs against the shop or section using the goods.

Oncost.

In the cost ledger a separate account is opened under the headings of each standing order number. As an example, under the heading of plant maintenance all wages and material charged would be entered. Transfers would be made to the departments for which work has been executed. General oncost would carry such charges as could not be accurately allocated, and this would be cleared pro rata to the departmental production accounts. In this way oncost elements would be aggregated for each section, and the direct wages applied to this would be the percentage of oncost to be added to each production job passed through such section or shown on the cost card.

Ledger Accounts.

Most wages and material expense would be charged in accordance with the foregoing instruction. There still remain items of expense not of a tangible nature, such as depreciation, gas, water, light, heat, power, etc. These appear in the miscellaneous column of the purchases book, and are posted in monthly totals to nominal accounts.

Box parts, grids, and similar foundry tackle, when made specially for definite castings, are written off against the client's order number so far as wages expense is concerned. The metal cost is transferred to the box-part account in the stores records. The expenditure so chargeable on tackle is kept in suspense and spread over the whole period of production.

Each month the credits to stores under the headings of production materials, buildings, plant and tool maintenance and general oncast are transferred *viâ* journal to the books of final account.

Transfers from wages control to production and different maintenance and oncost accounts are effected in a similar manner. In this way the cost accounts are brought into combination with the main financial books.

Whilst the cost accounts find their way into the nominal ledger in a summary form, the costs figures show the (*a*) production value of each type of casting; (*b*) the cost in each section; (*c*) the cost of each department included in production, maintenance or service, and, in addition, (*d*) they provide valuable data for the works management.

Monthly Reports.

To provide comparative figures in broad outline and to show the trend of events in a form which can be comprehended at a glance, a report is prepared by the works accountant to cover a costing period, and copy is forwarded to interested parties which forms a subject for the manager's monthly meeting.

As a minimum, there should be certified:—

(*a*) The rate per cent. in each section for moulding, coremaking, machining and fitting up.

(*b*) The oncost percentage over all, and departmental oncost in each section.

(*c*) The metals and melting cost per cwt. of each class of metals.

ARTICLE..... Bin and Stores Ref. No.

STORES LEDGER.

RECEIPTS.							ISSUES.						
Date.	Stores Inwards Book	Suppliers.	Quantity. Weight	Quantity. No.	Rate	Amount	Date	Dept. Chargeable	Quantity. Weight	Quantity. No.	Rate	Amount	

FIG. 12.—STORES LEDGER.—THE REVERSE SIDE OF THIS CARD IS DESIGNED TO CARRY THREE DETAILED "ISSUES" COLUMNS.

If the box-parts cannot be used on any further occasion the value of the metal is still an asset, and the cost of manufacture and fitting has been accounted for previously.

Depreciation.—Each machine, cupola, core stove, etc., is numbered and an inventory card prepared giving, *inter alia*, its value and location. The cards are grouped into sections, and when a machine is moved from one section to another the appropriate card is similarly changed. The total depreciation chargeable to any section is definitely arrived at by adding the values shown on the cards covering the respective departments. Depreciation reserve is credited in the costs ledger, and the various sections or shops are debited. A value is placed on buildings, and depreciation is charged to the department thereby served.

Power, gas and water are metered to departments, the readings being taken monthly, and balanced with the amount of the accounts when rendered.

Rates, taxes and insurances are charged to departments in the same ratio as depreciation.

Heating.

Heating expense, where necessary, is distributed in proportion to cubic capacities. It will be observed that nearly the whole expenditure has been allocated on an actual expense basis, and a comparatively small amount only is carried to general oncost to be allocated on a percentage basis as factory oncost. The direct charging of oncost, whilst involving more detailed labour, is the only correct method, and solves all difficulties created by incorrect returns under other systems by spreading oncost as a percentage on direct wages, wages and material, or by time rate method.

(*d*) The total average cost of production per cwt. for each sectional division.

(*e*) Certain main items of oncost expenditure will be shown under separate items, such as oncost wages, maintenance, shop supplies, fuel, etc. In order that variation of amount under these heads due to natural rise and fall of output may not obscure the relativity of the figures, the rate per cwt. should also be shown so as to make the comparison on a uniform basis. The items requiring further elucidation would be referred to the works accountant, who could supply the item of expense for examination in minute detail, which the records would supply.

(*f*) Output in tonnage in saleable castings, defectives, tackle, metal run off unused, and loss in melting, with separate weights for each. These should also appear in percentage ratios to the whole metal charged into cupolas, and to saleable castings.

The figures should be graphed for the convenience of the busy man.

CAST-IRON PAVINGS.—A test on the efficiency of cast-iron and cement paving has been made on the sea front at Algiers, which was found difficult to keep in repair by the insertion of patches containing 16 and 25 cast-iron cells to the patch. The cost price, carefully worked out by M. Salle, goes to show that for a sq. metre made up with 25 castings and a fair amount of cement costs 48 French francs, whilst with 16 under the same conditions works out at 40 francs. When using less cement the figures are reduced to 46 and 39 francs per sq. metre.

Some Castings for Internal Combustion Engines.

By Ben Shaw and James Edgar.

The Pattern-making for Crankcases.

It is usual to regard the cylinder as the most difficult casting of an internal combustion engine, but although the coring may require more careful watching than with the crankcase, the pitfalls into which the patternmaker or moulder may fall are as numerous in the one case as in the other. Even the highly-skilled craftsman on a first examination of the average crankcase drawing may find it more awkward than the average cylinder. The reason is that so many dimension lines are necessary. The crankcase made in aluminium, the top half of which is shown in Figs. 1 to 5, is quite a representative type. There is much variation of detail in crankcase design, but there would be no gain in showing several designs as all have to conform to general principles, and the object of these articles is not so much simply to describe a few jobs, but to describe them in such a way that the reader will get a grasp of the underlying principles of construction which are most suitable for this class of work. In setting down the work the patternmaker should not simply copy the blue print, but should put as few lines as possible on the drawing board. Some patternmakers put far too much detail in the working drawings, which confuses the assistants. The main outline should be set down giving metal thicknesses, and branches and feet should also be shown, but small bosses and ribs may very conveniently be left off, as they can easily be picked up from the blue print. When the patternmaker's drawing is completed it should not be necessary for him to refer continually to the print. Such references indicate a lack of confidence in his own drawing, and may lead to serious mistakes. Even if a first-class drawing is provided by the drawing office the patternmaker has to use his own judgment in matters of detail, and this applies to all classes of work. Thus the workshop drawing may differ in some respects from the print, and especially if assistants refer much to the print inaccuracies may occur. It is the practice in some pattern-shops to allow no one to look at a drawing except the man responsible for the work, and although there are important objections to this, yet there is something to be said for it.

The Drawing Board.

In a pattern shop doing big engine work or machine-tool work the drawing boards are not always such as could be desired. Great accuracy cannot be obtained by drawing on a board, the whole surface of which is scratched with scriber lines, and this is the great objection to the blackboard which is never re-planed. If a blackboard is smooth, however, it is really preferable to a white surface. The best drawing board for fine work is undoubtedly a three-ply board. There are no joints and the surface is hard. A contentious point often in setting down is the number of views that should be shown. In making first-class patterns time spent in making an accurate and full drawing is never wasted. Under no circumstances should views be drawn one on top of another as is often done when making large patterns. The practice is objectionable, chiefly because of the thickness of the metal. Each view should be drawn in correct relation to the others and the machining marked on finally. On no part should it be necessary to leave more than ⅛-in. for machining purposes.

In constructing the pattern for this crankcase consideration must be given to the customary method of moulding in the foundry where the castings are to be produced. This is advisable, as some foundries prefer to cast the flange down, while others have little trouble in producing sound castings with the flange cast in the top. The difference in the method of constructing the pattern mainly concerns the prints. To prevent confusion, for the purpose of describing the pattern work, it is assumed that the flange is to be cast down. As with water-cooled cylinders all loose pieces should be dovetailed where possible, both to save the moulder trouble in loosening off and also to ensure that they will be replaced correctly.

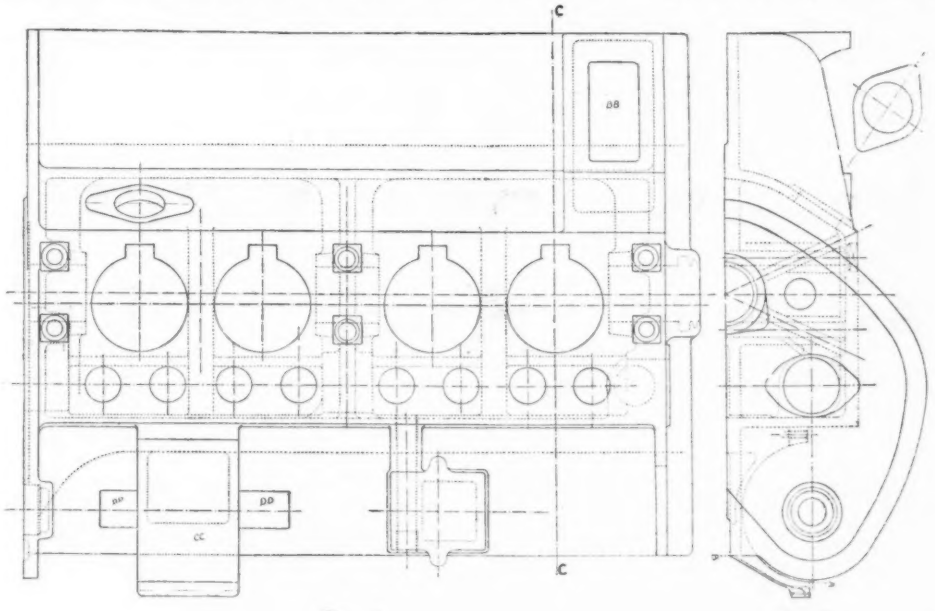


FIG. 1.

FIG. 2.

The first operation in making the pattern is in jointing the flange, which forms the base of the pattern. It is very thin and does not lend itself to a half-lapped frame. Curiously enough, pattern shops doing this class of work seldom use such frames. The objection is quite reasonable here if the spaces between the ribs will not be closed or covered, but the half-lapped frame where possible is certainly the strongest plate. The method of jointing two or three thicknesses edge to edge and insetting cross battens half the thickness is not recommended with so thin a plate, and undoubtedly the best plate is obtained by dowelling, as shown at Fig. 6. Thin pieces, "slithers" they are sometimes called, should be temporarily inserted between the boards, the dowels, of course, being glued. Patternmakers who believe in open-joints frequently close dowel-joints because, presumably, they are afraid of the glued dowels not being suffi-

cient to prevent them from being knocked together. The dowels are not really a source of strength, but should be regarded as a convenience while planing and shaping the flange. To prevent accident it is advisable to screw battens on this plate while cutting the recess to leave the facing. It is much better to mark the flange the full thickness over the facing than to make the facing separately, as it is so thin.

Attention is drawn to the fact that the ribs

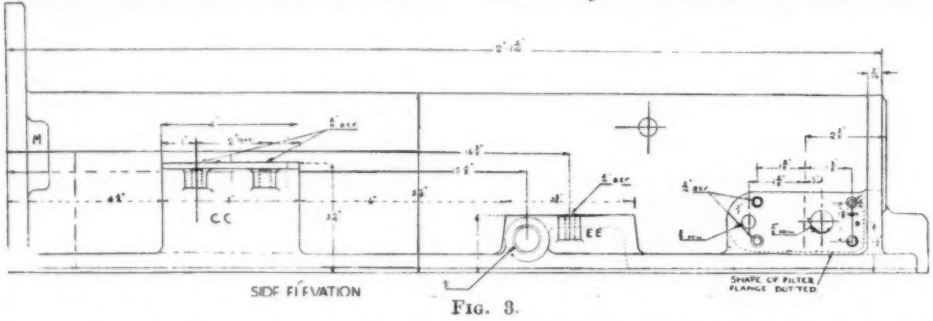


FIG. 3.

which support the bearings at the end and centre are not on the joint. It would not be a safe job to attempt to core under those ribs, therefore the 3/32-in. plus machining is cut from the flange face and the main print is framed to the rib outline.

The body of the pattern might be in one thickness of timber, if timber sufficiently thick is available, but if not it would have to be jointed up.

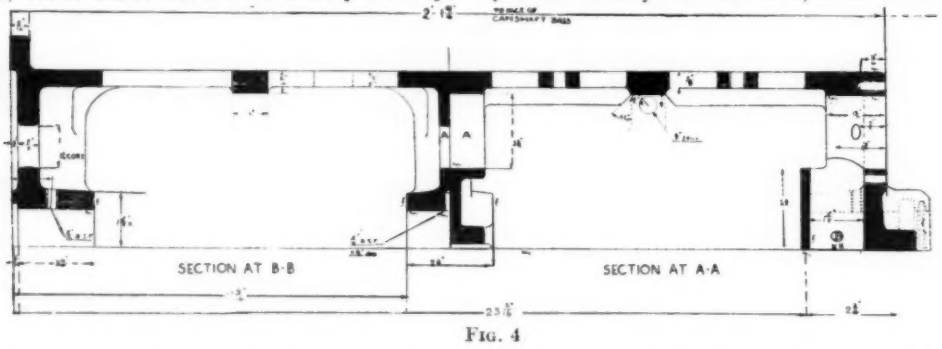


FIG. 4

It is too small to be boxed. Figs. 7 and 8 illustrate different methods of building the body block. It will be noted that the back-to-back principle with the annular rings tangential is observed. Fig. 8 shows the better way. There can be no interference with moulding caused by a top horizontal part swelling more than a bottom part, and if the timber is carefully jointed and good glue is used it will retain its shape as long as the pattern can be moulded from.

In order to bind the pattern well, the end flanges

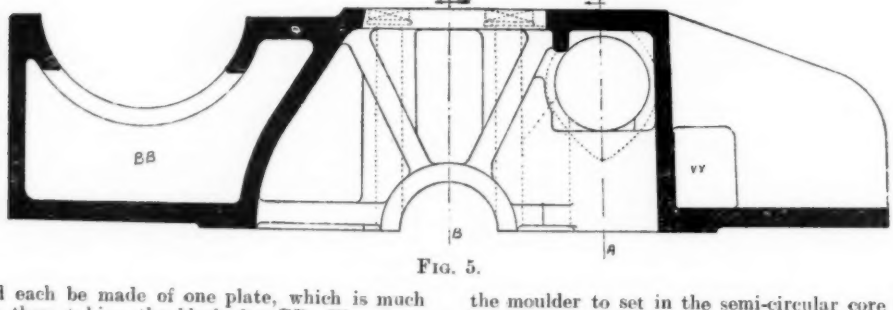


FIG. 5.

should each be made of one plate, which is much better than taking the block for BB, Fig. 5, to the face and fitting the flange against it. The loose pieces A, Fig. 9, should be wired or screwed on as they are too thin to be dovetailed.

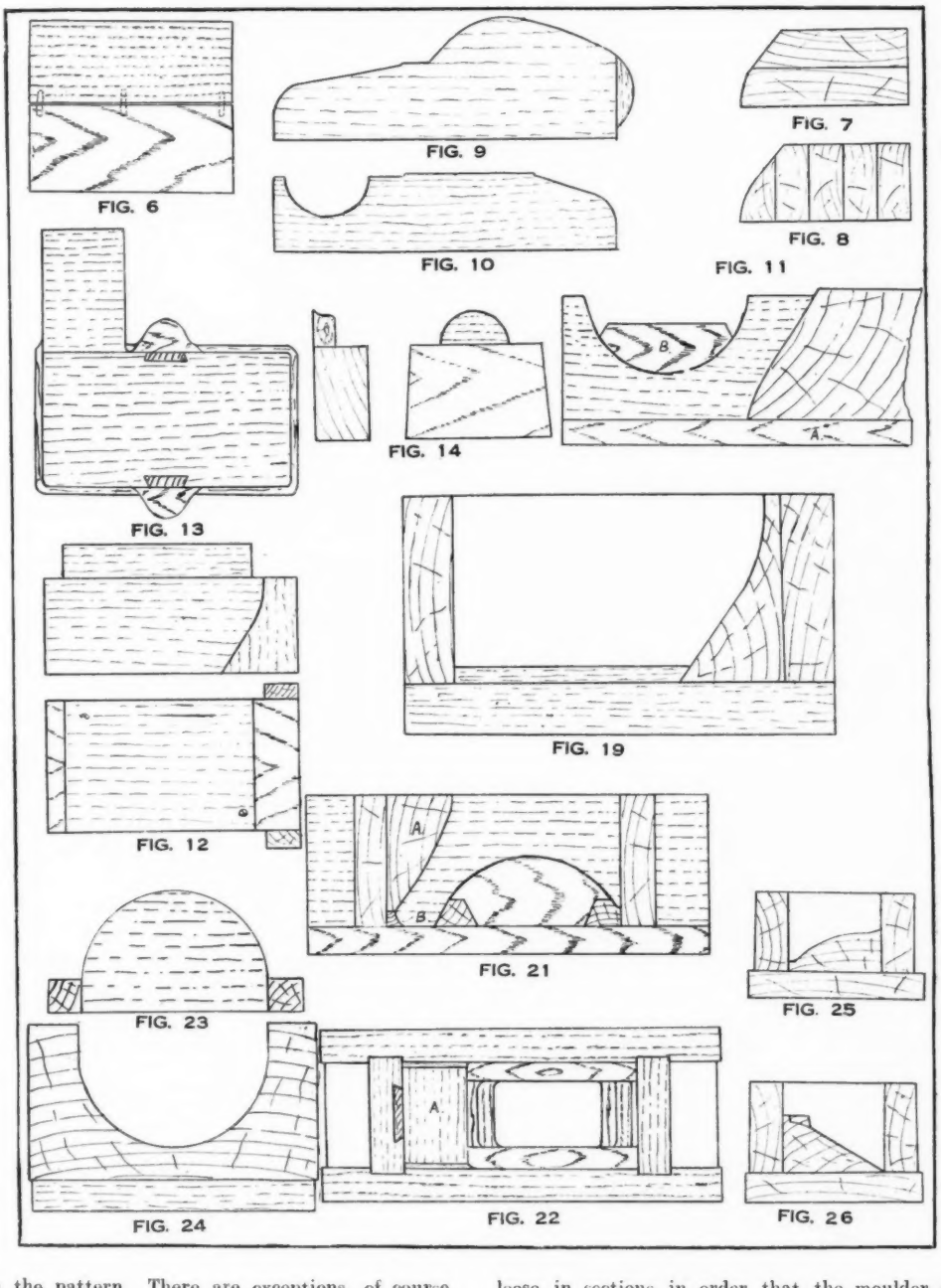
In the block BB, Fig. 5, it is possible to core the whole of this block, but it would not be a neat job. The bearing core would in any case have to be made in a separate box printed so that the under-core should rest on it, and the trouble that would be involved in the foundry is obvious, hence it is suggested that the method shown at Fig. 11 is the better way.

A is a batten which is fitted into a check cut across the main block and thus binds together the two parts, whilst B is the print for the bottom core. There are still the two blocks CC and EE, Fig. 3, to be made. The block EE is comparatively simple. It is shown with the D-shaped boss as being cut from the same piece of timber, which is more satisfactory as it reduces the number of pieces for final assembling. The small bosses could easily be dovetailed. The fillet at the base of the block could be made quite well from leather. The print for this block is, of course, on the face of the flange, as the core breaks through on the face.

Fig. 12 represents one of the trick pieces of the pattern. The experienced patternmaker might decide that as long as the piece projecting, which prevents delivery from the sand, is dovetailed on the body, and a core made for the inside, that there would be no difficulty. It is not uncommon for a foundry to receive a pattern beautifully made with all loose pieces dovetailed, but with one part so arranged that coring is impossible. The foreman patternmaker, in measuring work, sometimes overlooks such a point because he is so intent on measuring for accuracy. By referring to Fig. 2 it will be seen that the edge of the core at A projects considerably beyond the edge of the bottom flange, and it would thus be impossible for the moulder to set in the semi-circular core unless by making a drawback on the outside, and as drawbacks should be ruled out on repetition work if at all possible this matter may be dismissed. The only practical way, then, of surmounting the difficulty is to print on the outside, as shown in Fig. 12. If the print is made wider than the block the core cannot be misplaced.

The circular facing M, Fig. 3, is an instance where it is not sufficient to keep a facing loose, as it is too thick for the moulder to draw into the flange after the main pattern has been drawn from the mould. There is a choice of two methods.

Either the facing may be made of two thicknesses, each part being thinner than the flange, or a print can be made to the centre. In this class of patternmaking the former method should never be employed. It is seldom that a neat result is obtained, and the moulder is caused considerable trouble. Making a loose piece in two thicknesses is only excusable with rough work or in the case of a rush job when one or two castings are required in the shortest possible time. If a block print (Fig. 14) is made, the corebox and core do not occupy much time in making, and there is the additional gain that there is one loose piece less



on the pattern. There are exceptions, of course, but loose pieces should generally be considered as objectionable and eliminated if at all possible.

Some craftsmen favour the practice of screwing each part to the base plate as it is made, while others prefer to have all parts completed before assembling. The latter method necessitates close watching, and the man who has not perfected the gift of visualising usually builds as he works. The method of final assembling is certainly the better way if two or more workmen are engaged on the job, and when this is the case only the man responsible for the work should screw it together.

Every endeavour should be made in building such a pattern to eliminate cheek or pocket screws. This method of fastening is admissible on large work, but it is a clumsy and not always accurate method of dealing with small work. We have shown how the block BB may be held by a tongue crossing the main pattern block, and the custom of tongueing parts together is a wise one. It may be necessary to put in occasional cheek screws, but they should be as few as possible.

Before assembling proper, each block or flange should be as completely finished as possible. For instance, the facing on the end flange, Fig. 9, should be screwed on. This facing should be left loose in sections in order that the moulder can draw it into the flange, and although wires may be used and have the advantage that they are easily withdrawn and replaced, screws are more satisfactory all things considered, as screws hold the facing properly in position.

Figs. 15, 16, and 17 represent the finished pattern. In Fig. 15 it will be noticed that while a tail print has been used for the core A, the holes B and C have ordinary round prints. The reason for this will be made clear when discussing the moulding of the pattern. D is an end print for the bearing core, although this is not really necessary. When such a print is used on the end

of a bearing, however, instead of the facing print being carried out with the end print resting on it, the facing print should be flushed with the pattern and the end prints carried to the face of the other print. This prevents the possibility of the mould being torn by a lightly projecting edge. Fig. 17 shows how the flange binds the block BB to the main body, while Fig. 16 is a plan of the pattern. It is suggested that prints should be made for the square cores in order that they may be carried in the cope, but all the other openings should be painted in to guide the moulder. A foundry is not a convenient place in which to study a drawing, and the average moulder likes the pattern and

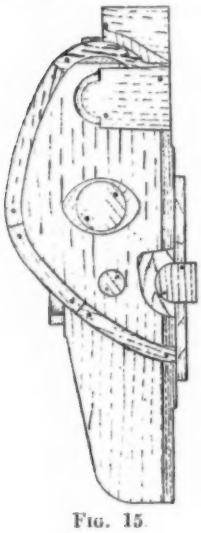


Fig. 15.

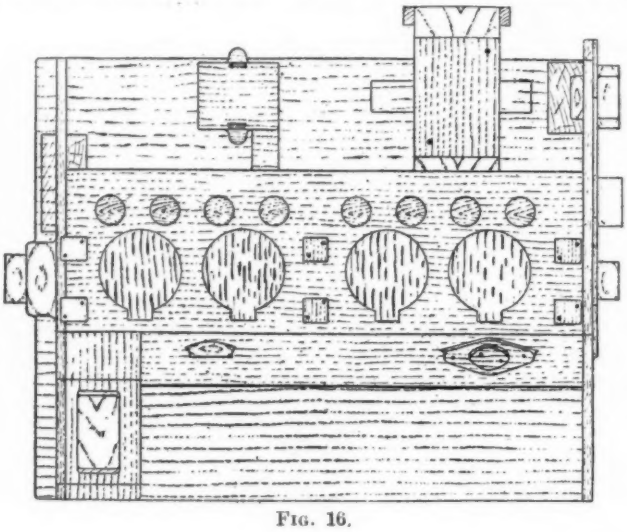


Fig. 16.

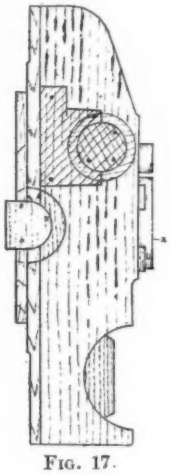


Fig. 17.

core-box to be his drawing; consequently, wherever the core breaks through the metal, even if prints are not left, the core surface should be painted a different colour from the rest of the pattern. It is also a good practice to indicate all loose screws by painting round them. Moulders, on getting a pattern, generally make it their first business to examine it carefully, determine their joints, and ascertain the parts which will have to

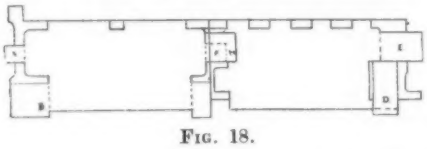


Fig. 18.

be loosened off. Sometimes, however, a loose part may be overlooked and afterwards cause trouble. This is scarcely possible if the screws are marked as suggested.

The final operation apart from painting and varnishing is, of course, the filleting and rounding of corners. To save confusion, some of the details

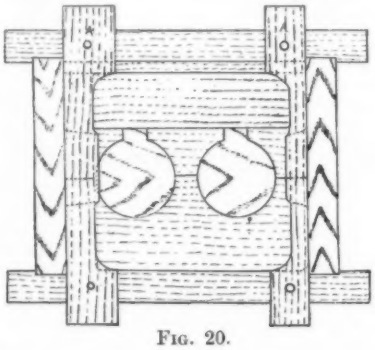


Fig. 20.

have been left off the finished pattern, Figs. 15, 16, and 17, but attention may be directed to the gland-shaped facing in Fig. 16. This must be left loose, as also the print. In such a case it is well to screw the print from under the facing so that the moulder by loosening the facing will also loosen the print. A separate core must be made for this facing.

The Core-boxes.

The most important box is that for the main core, and a decision has to be made whether this shall be in one or in two cores. In the job before us the rib on the centre and the round core which penetrates this rib constitute a difficulty, so that while it would be possible, by having loose pieces, to use one core-box, yet the core-maker would divide it into two cores, for convenience in handling, hence it is much better for the pattern-maker to decide on making two separate core-boxes. It would be possible, of course, to make one core-box half the length of the crankcase and alter it for each core. This is quite all right if only one or two castings are wanted, but it is not economical for repetition work and it increases the possibility of error.

Fig. 18 shows clearly the coring of the body, the dotted lines indicating the joining of the various cores. A is a round core, and in common with most round cores may be ignored by the pattern-maker. B and C are bearing cores, and it will be noted that the print for these cores is thicker than the main print to facilitate setting, and this also applies to the print for D. The core E is not round throughout its entire length because of the joining with E, and the print at E should be shaped so that the core will only go in one way. For the round cores F and H, which are fitted into the main core, the patternmaker should make core-boxes so that they will be the exact length required.

The main core-box in length and width will be the distances between the walls of metal, while in height the size will be the overall size from the face of the main print to the top of the crankcase. The first operation is to make a frame box with a bottom, the bottom of the box corresponding to the top of the crankcase. Fig. 19 is a section of the box with a block fitted to define the shape and a thickness set on the bottom through which the holes on the top of the crankcase can be cut. Fig. 20 is a plan of the core-box with some of the minor details left off. AA are the bearing supporting ribs. It is not strictly essential that these should be set into the sides of the boxes, but it is better. The bearings can be screwed to these ribs, and if dowels are inserted into the box sides the core-maker, after he has rammed the core, can lift the ribs off and free the core. There are several ribs in these boxes, and where these must be loose, fillets should be cut from the solid timber. As with the pattern the final task should be filleting, which must be well done, as nothing interferes with the delivery of a core from a box more than sharp corners, and they can nearly always be obviated. Both these boxes, except in detail, will be identical. The prints for the cores AA, Fig. 4, will only be in one box, of course, otherwise they could not be set.

Sometimes the practice is adopted of shaping all the prints in this class of work; that is, a taper

of, say, 3/16 in., is given to each side of a print, and the core-box is made to suit. This involves considerably more labour, and for the majority of cores there is not any great gain. It is better to give a slight taper to the print, both so that it will leave a clear impress and also that the core will enter with comparative ease.

The core-box for the part BB, Fig. 5, is perhaps the most difficult after the main boxes, although there is no real difficulty in making it. As in the case of the main box, an outer frame is first made. A cross section of this core-box is shown in Fig. 21 and a plan at Fig. 22. The block A must be withdrawn from the core, and the dovetail method, as shown, is best. The side fillets are shown as made separately in Fig. 22, but this is a matter of convenience and also to obtain a strong fillet if the block is made with the grain as shown. So that a good fillet is obtained where this end block joins the bottom, a separate piece is made of the fillet (B, Fig. 21). The other parts of the box are clearly seen in the sketches and require no explanation. It is advisable to taper the sides of these boxes slightly as a really good finish must be obtained to ensure free delivery of the core. If the box must be loosened leather fillets are unsuitable, and, instead, the ends of the box which are checked into the sides must be made thicker according to the radius of the fillet, and the fillet afterwards shaped from them. Some craftsmen when making small, narrow-framed boxes make the ends so that the end grain of the timber will show on bottom and top, the reason for this being that if the sides shrink or swell the correct depth of core is always maintained by the ends. Whatever advantage is gained in this way is lost in the width of the box. If good dry timber is used, especially if it is mahogany or baywood, correct sizes will be preserved.

Figs. 23 and 24 illustrate two different methods of making the bearing cores. Fig. 23, which is really an ordinary framed box with shaped ends and without a bottom, is quite satisfactory for all large work and a great deal of small work, but when a very large number of small cores have to be made it is as well to make the core-box shown in Fig. 24, which can be very quickly cut out. The bearing cores are of different lengths and one of them is in three or four different diameters, but it is so small that it is better to carve it from solid timber than to build it up.

Two core-boxes have to be made for the block CC, Fig. 3, one of them being for what is really a lightening core, which beds into a print screwed on the face of the main flange. Fig. 25 is a cross section of this box, which is quite simple, as is also the box for the coring of the outside of the block (Fig. 26).

There are several other boxes to be made, such as the one for the tailprint M, Fig. 3, but they are easy to make, and would probably be given to an apprentice. In Fig. 5, for instance, a square hole is shown through the end flange, and this must of necessity be cored.

Publications Received.

"THE COLOMBIAN TRADE REVIEW, JANUARY, 1922," price 1s. Published by the Colombian Bureau of Information and Trade Propaganda, 7, Sicilian Avenue, Southampton Row, London, W.C.1.

THE PORT OF SWANSEA. Published by the Swansea Harbour Trust. This book, which has been compiled by Mr. H. N. Appleby, gives details of Swansea dock facilities, tides and much general information.

"THE MANCHESTER GUARDIAN ANNUAL REVIEW, 1921." The "Guardian" Offices, Manchester.

BRITISH INDUSTRIAL "SAFETY FIRST" ASSOCIATION THIRD ANNUAL REPORT. Offices: 15, Savoy Street, London, W.C.2.

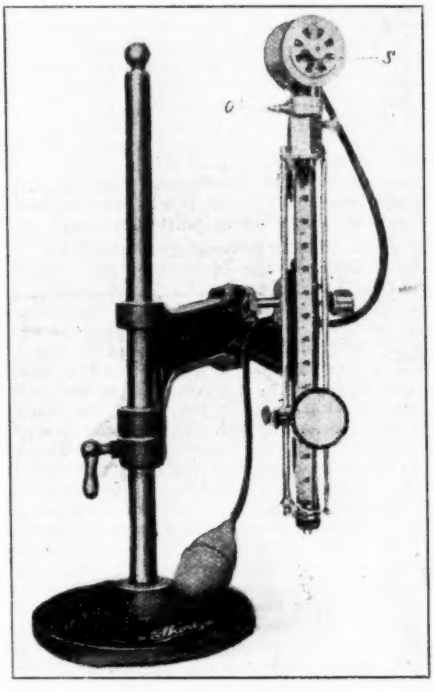
YEAR BOOK OF THE SECRETARIES' ASSOCIATION FOR 1921. Bassishaw House, 70a, Basinghall Street, E.C.2. Price, 5s. This book contains a complete list of members and the lectures delivered at their meetings during the past year. Amongst the subjects dealt with are:—Life assurance, superannuation funds, parliamentary and municipal government, profit-sharing and co-partnership schemes, and the transfer of shares.

An Improved Scleroscope.

As is well known, in hardness testing the surface resistance of metals must be overcome as by application of a given force on a spherical point. This operation leaves permanent indentations of a size varying in proportion to the material's resisting power or hardness.

The Shore direct-reading principle, embodied in the scleroscope, is convenient, and is applicable to not only soft metals but the hardest steels as well. To this end is utilised a diamond-tipped hammer, which, after falling, indents the metal microscopically and then rebounds to a graduated height which is in exact inverse proportion to the size of the indentation. Notwithstanding the great speed at which this instrument may thus be operated, full accuracy is maintained. Comparatively little or no nervous fatigue is involved, hence it has best met all requirements of economical and commercial hardness measuring.

The demands made on the scleroscope recently, however, have been so intensive and often under such adverse conditions that its manufacturer, the Shore Instrument & Manufacturing Company, has made a closer study of the advanced conditions of its application, with a view to improving it further. The refinements made so



AN IMPROVED SCLEROSCOPE.

increase the flexibility of the operating mechanism that it will give more uniform service even though the adjustments are comparatively approximate and the working conditions, including the skill of the operator, are less favourable.

Among the features are: (1) Special fine screen *S*, for eliminating dust from the operating mechanism; (2) the leather operating piston formerly used has been replaced by one of tungsten steel, which is practically indestructible; (3) the former rigid adjustments of the hammer-hook mechanism have been replaced by a flexible adjustment *Q*, which also greatly prolongs the life of the glass tube; (4) the hammer hooks have been provided with shock shoulders, which eliminate breakage or disalignment of these parts. In addition, more highly perfected glass tubing is being employed.

Altogether the refinements that have been added to the Improved Scleroscope Model C-1 has greatly increased the ease of operation under all conditions and speeds. This advantage will be appreciated by the painstaking laboratory man, as well as by the modern precision manufacturer, whose problem is one of quantity production.—"Chemical and Metallurgical Engineering," Vol. 25, No. 24.

Institution of British Foundrymen.

LANCASHIRE BRANCH.

Annual Dinner.

The annual dinner of the Lancashire Branch took place on January 14, at the Grand Hotel, Manchester. Mr. W. H. Meadowcroft, Branch-President, was in the chair, and there were also present the President of the Institution, Mr. Oliver Stubbs, the Lord Mayor of Manchester, Councillor E. D. Simon, Capt. Hilton, Mr. A. E. Cadmen and Dr. Brislee. Alderman F. J. West, the President of the Manchester Association of Engineers, was prevented from attending by the death of his father, Mr. John West, on January 12.

After the toast of "The King" had been proposed by the Branch-President and duly honoured, Mr. H. L. Reason, of Birmingham, proposed the toast of the "City and Trade of Manchester." In a brief, historical survey, he explained the derivation of the name Manchester from the Mancunium of the Roman period, and touched upon some of the chief landmarks in the history of the town. Coming to the present day he stated that in the Manchester district there were 57 foundries, and in Lancashire as a whole there were 350. Manchester engineers concerned themselves with many varieties of work, motor-cars, gas and oil engines, mining, electrical and textile machinery. The Corporation had recently done something to encourage industry, for they had placed an order for 54 miles of steel mains to bring water from Thirlmere. The work was going to cost £500,000, and it was the largest contract placed by any municipality for many years.

The Lord Mayor responded to the toast. He said he understood the Institution was somewhat different from the engineering institutions, and its object was the study of technical questions in connection with foundries. It appeared to be an extremely valuable form of work, and he was glad to have learned so much about it. But though technical knowledge was very important, there was another thing equally necessary, the study of which had been neglected. It might be described as the psychology of the workman. The real trouble in the engineering industry was due, not to lack of technical knowledge, but to the absence of harmonious co-operation between employer and employee. Limitation of output was particularly bad. In other industries, for instance, cotton-spinning and weaving, there was no objection to payment by results, and the engineering employers were unanimous in desiring the application of that principle, so that they might get a satisfactory output and maintain the position of the country. Otherwise, they were handicapped in meeting the competition of the German and the American, both of whom had such a system. But for some historical or psychological reason almost all the engineering Unions were opposed to it. He would like to see Institutions of this sort trying to find out why there was this misunderstanding between employers and employed in the engineering and foundry trades, whether some scheme could not be devised which would be acceptable to both sides and advantageous to the industry as a whole.

Mr. A. E. Cadmen, in proposing the toast of "The Institution of British Foundrymen," said he had recently taken a few train journeys in the company of the President, Mr. O. Stubbs, and it was impossible to do that without hearing about the Institution and being told of the progress it was making. He was particularly pleased to find there were about 20 subscribing members. It showed that the Institution was receiving recognition in a quarter where it ought to have recognition—among the employers. He had also had the pleasure recently of negotiating with the President and with a special Committee appointed by the Council in regard to the medal to be presented by the National Ironfounding Employers' Federation. The Council had accepted the offer of that body to give £200 to provide a gold medal to be given annually at the discretion of the Council to a member who had done meritorious work for the Institution during the year. That was an example of the interest taken in the Institution by the employers in the foundry industry. The one thing above all that called for encouragement and admiration was the efforts of the members to acquire technical knowledge and to solve, both on the practical and theoretical sides, the problems of the foundry.

The President (Mr. Oliver Stubbs) replied. He said he was very sorry that the esteemed Secretary of the Branch, Mr. Hogg, was prevented by illness from being present. He did not think any Branch secretary was held in higher esteem than Mr. Hogg.

He was pleased that the Institution was growing; it had now reached the stage when employers were recognising its work. That a body of men after working in foundries, which were not the most pleasant places to work in, should be willing to give up a good deal of their leisure time to improving themselves in their business and increasing their values to the employer, was a very gratifying thing and worthy of recognition. During his term of office another branch of the Institution had been formed under the name of West Riding, Yorkshire; it would take in Leeds, Huddersfield, Keighley and surrounding towns, and the headquarters would be at Bradford. He thought it would not be long before the Branch had 60 or 70 members.

They would also be pleased to know that among the subscribing firms were such names as Vickers, Cammell Laird, and Armstrong, Whitworth. They had all been delighted that this year Manchester had chosen its Lord Mayor from the engineering industry. Councillor Simon was a member of Messrs. Henry Simon & Company, Limited, and also head of the firm of Simon-Carves, who, he believed, would undertake engineering work of a magnitude that hardly any other firm in the country could surpass. In spite of foreign competition, they had secured an elevator contract at Durban. In future that firm would be included among the subscribers to the Institution. The Lord Mayor had given him permission to propose it.

His advice was, keep on with the good work you are doing, and do not get downhearted. Times were bad, and it was more difficult for all of them to meet the expense of living, but the times would not be always bad, and they must put things in order now so as to be prepared to take again the place and position they formerly occupied. Especially did he urge them to do their best to bring about a better feeling between employer and employee. The best propaganda work could be done in the shops, and it was infinitely better than Whitley Councils or Industrial Boards. Go amongst the workpeople and let them see that they were trusted, and they would return the trust. He had had the pleasure of handling the original Royal Charter granted to the Institution. It gave them a high standing, and he was proud to be connected with an industry which was now looked upon as one of the principal key industries of the country. Let them never give cause for anyone to say that it was an industry that was not making progress.

Mr. W. H. Cook, in proposing the toast of "The Visitors," mentioned that Manchester was the centre of perhaps the biggest engineering population in the world. He drew attention to the fact that while Mr. Oliver Stubbs was President of the Institution his brother, Mr. J. H. Stubbs, was President of the National Engineering Employers' Federation.

Mr. J. H. Stubbs, replying to the toast, said he believed it would be a very good thing for the Institution if employers and men could get together and have a real common-sense talk upon the difficulties of labour in foundries and other work. He believed the time was coming, perhaps more rapidly than most of them thought, when there would be a better understanding than there had been in the past.

Musical and humorous selections were rendered by Mr. Harry Cubley and Mr. Fred. Cooper.

AN IDEAL FOUNDRY.

At a meeting of the Burnley section, held on December 6, Mr. J. Hogg presiding, Mr. W. H. Cook, M.I.Mech.E., delivered a lecture on "An Ideal Foundry," in which he considered the matters which would come up for decision in erecting and equipping a foundry suitable for producing repetition work in fairly large quantities of medium weight castings.

Ventilation.

Dealing with the building itself he said that in the past the moulder had had to work under bad conditions, and even in modern foundries the conditions were far from ideal. Some were outwardly very pleasing to the eye, built of pressed brick with close joints neatly pointed, and with pillars and recesses of decorative design; but inside there were rough ordinary bricks and wide, unpointed joints, which provided resting places for dirt and dust, and made it impossible to sweep properly the walls or to whitewash. If pressed bricks could not be afforded both inside and outside, he would put the common bricks outside, and use the smooth pressed bricks internally. To facilitate cleaning and prevent the accumulation of dust, all the corners should be rounded, not square. He did not believe in lofty walls. If it were not intended to instal a travelling crane he would not exceed a height of 14 ft. to the eaves. In the construction of the roof he would depart entirely from the present-day practice, and follow the methods adopted in the latest weaving-shed designs of carrying the roof upon beams placed outside, and making the inside as smooth as possible. It should all be painted or whitewashed. To ensure light and brightness there should be as much glass as possible.

If it was necessary to have a travelling crane and the roof was high there should not be a depressing blank wall but a side light should be incorporated. Often a foundry was darkened by the rising steam and fumes. To overcome that trouble a ventilation expert should be called in, the conditions pointed out, and he should be instructed to devise the best possible scheme to carry away such fumes and dust and pass them into closed vessels of water in order to prevent their being deposited upon the windows or scattered through the neighbourhood. Were it possible every foundry should be compelled to put in mechanical ventilation, which would ensure proper air circulation even on the damp, muggy and foggy days. In the lecturer's foundry there was a signal proof of the advantages of mechanical ventilation. During the war this foundry was called upon to make large quantities of a 40 per cent. zinc mixture, and there were five or six men pouring throughout the whole of the day. This mixture gave off a white cloud of zinc oxide, which had a bad effect, even if only one was pouring. With six it was unendurable. A ventilation expert was sent for, and he so arranged the ventilation that no matter how many were casting or how much fumes arose, the atmosphere was cleared and made fresh in less than half a minute. The brass foundry was now the healthiest part of the shop. It suffered very little when influenza was raging.

Cupola Equipment.

It was very difficult to advise about the type, but on two points he had no hesitation: he would not have two heights of tuyeres, nor would he have the blast from only one side. The most successful cupola they had at work was 30 years old; there was no belt; the blast passed in at two tuyeres opposite to each other. The results were very satisfactory: hot soft iron, reasonable coke consumption (2½ cwt. to the ton); a good average life to the lining. They had none of the troubles due to fusing of the lining. This he attributed to the fact that the air inlets were of large area, about one-seventh of the area of the cupola. A Keith-Blackman combined electrically-driven fan was particularly efficient and economical. The full blast pressure was 10 ozs. These results were not often surpassed, and the simplicity of operation was very pleasing.

Some years back he was told of some marvellous melting results, using 1¾ to 2 cwt. of coke per ton of metal all in, at a foundry which turned out in jobbing castings about 30 tons per week. He was surprised to find the cupola was a home-made affair adapted from a boiler casing with two side pipes, no belt, and ample air inlets. When he tested he found the reports were justified. After such experiences why should one instal a complicated arrangement?

The Lay-out of the Cupola.

The position of the cupola was a matter of importance. As generally fixed the spout projected into the foundry, taking up much space and making the appearance untidy. He suggested that it should be put farther back, with a wide and high archway for approach, a large, covered-in stage to allow of good storing, with a self-registering weighing-machine sunk level with the floor, ensuring the charges being as desired from day to day. Another suggestion was to put a light roofed building over the pig-iron, coke and scrap stores. The cost would be more than repaid by the saving of fuel and labour in the wet winter months.

Plate Moulding.

The best system of plate moulding that could be found should be installed, and the plates should be finished as smoothly as possible, because the moulder could only give castings which were replicas of the pattern. A principle which he strongly recommended was that the patterns should all be made to part across a dividing line. In the case of a symmetrical pattern the line would be through the centre, in the case of irregular patterns the most prominent point would be chosen. In every pattern there was some suitable point. Even if the patterns were being used loose there was a decided advantage, as one part could be rammed on a flat board, then turned over, and the other part put into position for ramming in top part. This would save trouble for odd sides, jointing, and loose sand, which caused so many dirty castings in loose pattern moulding.

Plate-moulding Boxes.

The next point to decide was the sizes of standard boxes. There were many different opinions, but experience showed that a man would give a bigger production on boxes which were not too heavy; 18 in. × 14 in. was his maximum for one man to handle, and he preferred 16 in. × 12 in. or even 14 in. × 12 in.

Using the Plates.

Difference of opinion existed as to the method of using the plates, whether on the bench, on the floor, or in a machine. His experience was that with the hand-rammed, self-drawn machine the production was 10 per cent. greater than with the other methods, with less fatigue to the worker. Any intelligent person could be taught to ram and work the machine, and he should become quite efficient in one month. Only four thousandths of an inch play was required between the hole and the pin, thus avoiding twisted castings, and they could draw deep patterns without turning over.

Space Requirements.

The average space for each man should be 30 sq. yds. An area of 6 yds. × 5 yds. was sufficient with the ordinary small castings, but for large ones 40 sq. yds. was required. The man could produce, if he willed, at least 80 boxes per day; probably he could do more.

Jar Ramming.

The question might be asked: "Why not install jar ramming machines?" He had studied that matter for some time, and had visited other foundries to see what they were doing, and he had not yet seen a machine suitable for the shallow boxes his firm used; there was not sufficient weight of sand to give ramming pressure. Perhaps this difficulty might be overcome in the future, if so they would go farther into the matter, but so far as their inquiries had gone jar-ramming, with its overhead charges for upkeep, did not show any great saving. In fact, it was a long way behind the Lancashire plate moulder. He knew that in the Burnley district press machines were common, and did satisfactory work. It was a question of custom.

Overcoming Sand Troubles.

He came now to what, in his opinion, was one of the most important points in relation to the production of clean, smooth and sound castings. That was a question of sand. By far the greater proportion of blown and dirty castings were due to the sand; they were seldom produced by the plate moulder, but arose

usually from the loosening of the sand when rapping in loose pattern moulding. Many years ago he instituted a system under which on a particular day each week the bad castings were laid out and a clerk made a report, in conjunction with the foreman moulder, as to the faults, the cause of them, and the financial loss which arose from them. This procedure had very satisfactory results, the percentage of bad castings being reduced from about 6 to 2½ per cent. upon an output round about 120 tons per week. They found out how the losses arose. One moulder after casting up and knocking out his boxes would turn his sand over, water it, turn over again and leave it in a neat heap until the next morning. This allowed the moisture to permeate the mass. Another moulder would knock out his boxes and then leave everything. The next morning he would throw water over his sand, and cause some of it to resemble slush. Hard and blown castings were the result. Experience of this led him to insist upon every moulder following the former course, and ever since he had had in his mind the necessity, in an ideal foundry, of a system by which every moulder would be supplied each day with properly tempered sand. Up to the present he had not seen one which was quite satisfactory, but if he were erecting a foundry he would install the best one he could find. This, combined with the use of the proper quality of blacking and coal dust, would remove many difficulties.

Shanking Metal.

With regard to the carrying of the metal he had always considered that to carry it from the furnace in the shank was both dangerous and laborious, but it could only be replaced by the trolley ladle, and unless everything was systematically carried out the metal might become too stiff before pouring. To remove the possibility of delay as much as possible he recommended making the trolley axles dust proof, and using ball- or roller-bearings and cast-iron plated runways kept clean and free from obstruction.

A full supply of the necessary small tools, such as brushes, riddles, etc., should be kept.

Core Shop Suggestions.

He could say nothing very special about the cores except that he would certainly have that department isolated from the general foundry, with ample drying stoves and storage space. Every core should be numbered, and a certain number always ready in a place from which they could be given out to the moulder without his going into the core shop.

He was a great advocate of employing women in making small cores, on account of the greater neatness of their work. There were so many stoves to choose from for small cores, each satisfactory to a point, that no definite advice was necessary except to see that an outlet of large area was provided for the steam, etc. Cores did not require a great heat, but the moisture should be got away as freely as possible.

Trimming Shop Notions.

Great attention should be paid to the dressing or fettling department. It ought to be as pleasant to work in as any other, but that was not the case at present. The first step he would take was the provision of a system of runways to carry the castings from the foundry to the rattlers in tilting skips. The barrels should be constructed with the shaft running in roller bearings, the shaft not to go inside the barrel. The gearing should be at one end only, and there should be no strap to the framing underneath. This would remove any danger of accident, and allow of the castings being easily dealt with when the barrel was emptied. Finally, the whole machine should be enclosed by a sliding cover, with dust pipes attached and connected to a fan, thus carrying away practically all the dust into a water tank. There it would settle and could be periodically removed. He would provide ample emery grinders, all connected to the same fan. Finally he would have runways to carry the castings to the weighing-machine and the stores.

Ample storage boxes were needed, and also space for the examination of the castings before putting them into the boxes, so that any unsatisfactory ones which had passed the dresser would be thrown out and charged to the moulder, or rejected before any machining cost had been added.

Costing Department.

The costing department was often neglected, but he attached as much importance to it as to any other part of the foundry. But in arranging the method of costing he would take great care not to carry system too far. It should not be introduced if it made the fixed expenses too high.

An experienced foreman would keep things straight, and he would certainly appoint the best foundry manager he could find, who knew his business and was strong but just. To such a man he would give absolute control in regard to the workmen, reserving to himself the purchase of materials, the determination of the selling prices, and a fair criticism of results.

THE DISCUSSION.

MR. PELL said if Mr. Cook would start a company to build ideal foundries it would undoubtedly be a good thing for the members of the Institution, but some of the points made in the address were open to criticism. Fourteen feet was a very low level for the roof. One must remember that the employer was expected to provide so much cubic feet of air for every human being employed on the premises. If the 14 ft. gave them that amount no doubt it would be all right.

In his time he had heard a good deal about cupolas, and he expected to hear more. The fusion of linings had caused him much trouble, and he raised the question at a meeting in Manchester, and the conclusion arrived at by some of the members was that his tuyere area was not big enough. Since then he had made his tuyeres 4½ in. dia., instead of 4 in., and he proposed to increase it to 6 in. when he rebuilt.

Speaking of blast pressure, Mr. Pell said he was working with 15 ozs. According to Mr. Cook, such blast pressure should result in hard iron, but he had not found that to be so. The iron produced was not hard; some of it machined extremely well.

Replying to questions put by Mr. Barnes, MR. COOK stated that they weighed every ounce of coke that went into the furnace, and every ounce of iron. With regard to the trouble from steam, he advised the employment of mechanical ventilation. An expert should be called in and a fan of sufficient power installed.

MR. LAYFIELD said he had been concerned in putting up a new foundry, and many of the points mentioned by Mr. Cook came up for consideration. On the whole they were in agreement with Mr. Cook. But his insistence upon mechanical ventilation was rather alarming. They were taking the walls up 15 ft. to the eaves, and putting in louvre ventilators; so, from what had been said, trouble was to be expected. They had no rounded corners, on account of expense. With regard to the plaster mould in a jobbing foundry many things had to be delivered the next day in lots of twenty or thirty. Such could not be done without the use of plaster moulds, which were satisfactory for a small number of articles. When 100 or 200 were required the plaster mould was no longer useful. For carrying the metal they had an overhead system which he thought was the best. The metal was carried overhead on a single girder upon a trolley. It was much quicker than carrying on the floor, but there was some difficulty when there were a lot of byeways or corners to run round. With a straight run the overhead system was certainly preferable. Could Mr. Cook give any information as to the value of the sand blast for small castings and was it worth while to install such a plant?

MR. COOK replied that he had not mentioned the sand blast because it was so many years since they studied the question and decided that it was unsuitable for their work. It did not compare at all with barrelling and the ordinary methods of dressing. It was expensive. It was a better job in some cases but not in others. He did not approve of putting in louvres for ventilation purposes. They were of no use except upon a bright day, but the foundrymen had to make provision for the damp, foggy days—say, in November. With mechanical ventilation it did not matter how foggy a day might be, outside went the air. In the end mechanical ventilation was cheaper.

A vote of thanks to Mr. Cook concluded the proceedings.

Drafting Room Aids Foundry.

By F. C. EDWARDS.

Pride of craft has, in the past, carried men on to seemingly impossible heights of attainment, and nowhere has this manifestation of real grit been more apparent than in the foundry. It is still to be found there to-day, and is freely exercised. There are limits, however, to its successful application, beyond which other help should be requisitioned.

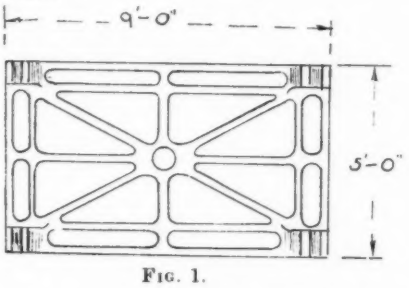


FIG. 1.

A typical case of this class came before the writer some years ago. A casting was required as shown in Figs. 1 and 2, which is plan and front elevation respectively of a large press table. It was essential that the bearing legs A, Fig. 2, should be perfectly sound, on account of certain heavy shocks to which they would be subjected when the machine was at work. It was therefore decided to mould the job the manner shown in Fig. 2, *i.e.*, legs downward. This would ensure soundness of metal in the feet. Though every precaution was taken to get the top clean, subsequent machining revealed certain imperfections which caused the casting to be rejected. Obviously, if the face of the table had been cast downwards

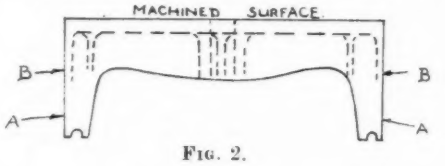


FIG. 2.

a clean surface could have been guaranteed. This desirable condition, however, would have placed in jeopardy the soundness of the bearing legs. Feeding heads were suggested, but, for certain reasons, were considered inadmissible, and, in any case, the legs could not perhaps have been so implicitly depended upon as when cast downwards.

Consider, briefly, the sequence of casting this table face downwards. The metal fills the mould from below. As it rises and passes along the deep narrow spaces that form the ribs it naturally tends to become sluggish. Carrying along with it an increasing amount of sullage—some of which it gathers on its journey through the mould—it ultimately reaches the legs. Here, probably in

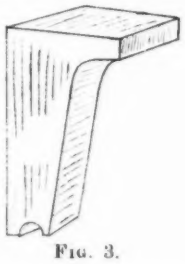


FIG. 3.

some cases adjacent to the corners where the legs join the body of the casting, this scum finds a lodgment. The skin of the casting may not reveal its presence, and it remains undetected until the load is applied; or, worse still, it remains as a potential source of future disaster owing to the cumulative effect of repeated shock. One may also expect a condition of porosity to be present in these relatively heavy legs. The difference in the rate of cooling would introduce another weakening factor, viz., the permanent internal strain set up by shrinkage stresses.

When the drafting room realised that the foundry were thus in a dilemma, they immediately altered the design to one in which the bearing legs were cast separately, as shown at Fig 3, and afterwards bolted on to machined faces, at B, B, Fig. 2. All was now plain sailing for the foundry; they could guarantee a clean surface on the top of the table, and, by casting the legs bearings downward, soundness here was also assured.

Incidentlly, another advantage was secured with separate legs. If, in handling in the shops, or during transit, one of the legs was broken—which is by no means a remote contingency, with the casting in one piece—a complete table would be required to make good the damage. With legs cast separately, however, the extent of the injury would be confined to the broken leg alone, merely necessitating another leg casting.

The British Cast-Iron Research Association.

The Director of Research reports that the character of the problems submitted for investigation and advice continues to be of general interest and importance, and during the month of December a large batch of problems has reached the Director.

It is particularly noticeable that defects associated with unsoundness, porosity and shrinkage continue to trouble the industry. Examples of such difficulties in heavy and light castings and in malleable work have been submitted and help sought in their removal. The variable practice in cupola operations, in the preparation of facing- and core-sands for definite types of castings has been again illustrated in several of the problems submitted. The synthetic preparation of sands and linings for high-temperature work is under consideration and trials suggested based on recent refractory research results.

In the domain of the light castings foundry problems connected with mixtures and treatment for light castings subject to shock have been investigated and advice given.

Certain abnormal structures in heavy and light grey iron and malleable castings have been submitted for investigation and advice tendered. Problems associated with the chemical analysis and testing of cast iron have been dealt with.

In many of the above cases data of a specially useful character have been obtained, such as is of service to the researches on moulding sands, cupola linings, shrinkage and draws and the pig-iron grading problems.

The influence of design has been of signal importance in some of the troubles experienced and the full particulars supplied in several of the most intricate problems under investigation have materially helped the Director in his conclusions.

Work is proceeding on the main problems of research, and data continue to arrive from members such as is of practical assistance in the carrying out of these somewhat lengthy researches.

The additions to the Library have been numerous and the entries in the index of the Bureau of Information now number several thousands. This information is now being made good use of regularly by the members.

International Foundry Trades' Exhibition.

In connection with the Foundry Exhibition to be held in Birmingham next June, at the Bingley Hall, a section of historical foundry exhibits is being arranged to include anything of cast iron work or non ferrous castings or anything which will be of historical or educational interest, such as prints, models, etc., as the exhibition is the first ever held in this country, and promises to be a great success; it is hoped to make the historical section as large as possible, so that it can be a thorough educational exhibit.

The Technical Advisory Committee will be glad of offers to lend anything for this section. The exhibits would be fully insured against loss or fire, etc., and every possible care taken of same, and they would be carefully packed and returned carriage paid.

Communications on this matter should be sent to Mr. Thos. Vickers, C.E., Central House, New Street, Birmingham.

Trade Talk.

THE SOUTH DURHAM STEEL & IRON COMPANY, LIMITED, have restarted a mill at their Malleable Ironworks, Stockton.

R. THISTLEWAITE & COMPANY have removed from Corporation Street, Manchester, to 27, King Street, Manchester.

G. & R. THOMAS, of the Hatherton Furnaces, Bloxwich, propose putting one of their furnaces into blast in the first week in February.

OPERATIONS HAVE BEEN RESTARTED by the Whitford Steel Sheet and Galvanising Company, Limited, Briton Ferry. The works have been idle for many months.

AT A MEETING of the West of Scotland Iron and Steel Institute, held in the Royal Technical College, Glasgow, on January 20, Mr. J. E. Hurst read a paper on "Centrifugal Castings."

IT is understood that unless things improve within the next two weeks the Consett Iron Company, Limited, will damp down one of the three furnaces they have in blast at present.

A MEETING of the members of the Staffordshire Iron and Steel Institute was held at Dudley last Friday, at which a paper on "Electric Welding" was read by Mr. H. W. Wolton.

MEMBERS OF THE Sheffield Branch of the Association of Engineering and Shipbuilding Draughtsmen met on January 20 to hear a lecture on "Power Transmission by Chain," given by Mr. A. Bayliss.

THE ELECTRO-MECHANICAL BRAKE COMPANY, LIMITED, Eagle Works, West Bromwich, have opened London offices at Donington House, Norfolk Street, Strand, W.C.2, with Mr. W. F. Knight in charge.

UNDER THE chairmanship of Mr. H. P. Wiley, a meeting of the Sheffield Rolling, Forging, and Tilting Trades' Technical Society was held on January 20. The lecturer was Mr. E. Lang, and his subject was "Sheet Steel Rolling."

THE LIGHT CASTINGS ASSOCIATION recently made an application before Sir W. M. Acworth's Committee at Old Palace Yard, for protection against the importing of cast-iron baths from Germany under the Safeguarding of Industries Act.

THE 24th annual dinner of North Countrymen, resident in the Midlands, will be held at the Albert Hotel, Derby Road, Nottingham, on Friday, February 24. The hon. secretary is Mr. R. Laverick, 2, Claremont Gardens, Sherwood Rise, Nottingham.

A JOINT DISCUSSION for members and students of the Institution of Civil, Electrical, and Mechanical Engineers, was held in the Council House on January 20, on the subject of the electrification of main line railways. Sir Henry Fowler presided.

MR. J. MARCOVICI, 66, Victoria Street Westminster, London, S.W., agent for Comptoir Franco-Anglais Société Anonyme, has been joined by Mr. H. M. Hart, and in future the business will be carried on under the style of J. Marcovici & Hart, Limited.

THE NEWLY FORMED South Wales Branch of the Institution of Mechanical Engineers will hold a meeting in the Chamber of Commerce, Adelaide Street, Swansea, on Tuesday, March 14, when Dr. Lander will give an address upon the subject of fuel.

AT A MEETING of the Institution of Engineers and Shipbuilders in Scotland held in the Hall, Elmbank Crescent, Glasgow—Mr. Harold E. Yarrow, the president, in the chair—Mr. W. R. Darling described and demonstrated a new form of transmission gear.

AN ANNOUNCEMENT has been made by the Disposal and Liquidation Commission to the effect that inquiries in respect of surplus ferrous materials should in future be directed to the Pickett Metal Corporation, Limited, 22, Queen Anne's Gate, London, S.W.1.

UNDER THE AUSPICES of the Sheffield section of the Institute of Metals, an interesting paper on "An Investigation of Some Defects in Silver-plating Anodes," the joint work of Messrs. F. C. Robinson and H. G. Dale, was read at the University of Sheffield on January 20.

THE Department of Overseas Trade has received from Sofia specification and blue prints in connection with the call for tenders issued by the Bulgarian State Railways for the supply and erection, painting, etc., of thirty-one steel structures of various sections for bridges, telegraphs, etc., tenders for which are to be presented by February 16, 1922. Particulars at the Department of Overseas Trade (Room 50a), 35, Old Queen Street, S.W.1.

IN CONSEQUENCE of a statement that modification of the machinery for the registration of business names carried on by the Board of Trade has been suggested, the Policy and Parliamentary Committee of the National Union of Manufacturers have adopted a resolution viewing this suggestion with alarm, and requesting the Board of Trade to exercise the full powers given under the Act, and to take such steps as may be necessary to prevent evasion.

AT A MEETING of the Liverpool Engineering Society last week, a paper entitled "The Removal and Replacement of New Brighton Landing Stage Bridges by Floating Crane" was read by Mr. H. A. Whitaker. On February 8 Mr. J. Walwyn White will read a paper on "Aerial Wire Ropeways."

CLELANDS GRAVING DOCK & SLIPWAY COMPANY, LIMITED, Willington Quay, have performed a smart piece of work in repairing the Newcastle steamer "Constantine" in 11 days after the vessel had received heavy collision damages. Thirty-four new plates had to be riveted to the stem and side of the ship, the engines and boilers opened out, etc., and the vessel surveyed.

MR. N. W. PRANGNELL, 47, Pilgrim Street, Newcastle-upon-Tyne, has been appointed agent in the Northern area for the Twiss Electric Transmission, Limited, London Electric Firm, Limited, Electric Street Lighting Apparatus Company, Limited, Venner Time Switches, Limited, Berry's Electric, Limited, Scholey & Company, Limited, Automatic and Electric Furnaces, Limited, Chadburn's (Ship) Telegraph Company, Limited, and Ewart & Son, Limited.

THE INCOME TAXPAYERS' SOCIETY, with Lord Inchcape as president, has been founded to protect and advance the interests of all income taxpayers, to press for a reduction of income tax as soon as the financial condition of the country permits, and to obtain redress for income taxpayers from the many hardships under which they now suffer. Communications should be addressed to the secretary, Income Taxpayers' Society, Iddesleigh House, Caxton Street, London, S.W.1.

IN CONNECTION with the recent visit of the Japanese Commercial Mission to Edinburgh, the Edinburgh Chamber of Commerce made arrangements for a visit to the electrical engineering works of Bruce Peebles & Company, Limited. Considerable interest was shown at the amount of work at present going through the shops for Japan, including Peebles-la Cour motor converters and quite a number of induction motors (for the Imperial Japanese Navy and the Kure Naval Arsenal).

H.M. TRADE COMMISSIONER at Toronto (Mr. F. W. Field) reports that a Canadian firm are desirous of receiving quotations from the United Kingdom for the undermentioned material:—Brass tubing, 1-in. iron pipe size; copper tubing, 1¼ in., 1⅜ in., 4 in., all outside diameters in No. 16 B and S gauges. In the case of the copper tubes quotations are required for 500 lbs. of each size, and it is stated that the firm's requirements are from 2,000 to 3,000 lbs. monthly. Particulars at the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

THE PROGRESS OF SCIENCE in the foundry was referred to at the annual dinner of the Birmingham Branch of the Institution of British Foundrymen, held on January 21, over which Mr. H. Field presided. Mr. C. Retallack, chairman of the Willenhall and District Ironfounders' Association, said never in the history of the trade had there been such a hungering after right methods as at the present time. He had no fear for the future of the industry. There was a keen spirit of research, endeavour, and determination, and he considered the industry was on the way to recover anything that had been lost. All who were engaged in foundries now realised that the forces of foreign competition must be overcome. For many years little headway had been made, but now the industry was making its impression upon the nations of the world, and the activity of the young men in regard to research was very encouraging. Mr. O. Stubbs said that although trade at the moment was abnormally quiet, he thought it was on the turn. Everything possible should be done to put goods on the market at a price that would stimulate trade, and thus bring employment to those who were entitled to it. Mr. E. C. R. Marks, president of the Midland Branch of the Institution of Mechanical Engineers, remarked that by the application of abstract science foundrymen were now able to meet all the requirements of the engineer. Mr. H. B. Weeks, chairman of the council of the British Cast Iron Research Association, stated that, thanks to the mobilisation of our resources, we were able to make ourselves independent of, and even superior to, Germany in the production of materials needed. In order that we should never be caught napping again, research associations had been formed.

Societe Metallurgique d'Esperance, Longdoz.—This Belgian concern reports profits for 1920-21 totalling nearly 3,763,800 fcs. (£150,552 at par). Out of this sum, plus the amount brought forward from the preceding year, 4,500,000 fcs. are to be distributed among the shareholders. The shares are without indicated value.

Company News.

Fotherby & Company, Limited.—Capital £10,000 in £1 shares. Ironfounders. Directors: H. A. Tattersall and F. H. Waterhouse. Registered office: Hardy Croft, Wakefield.

W. & H. Cooper, Limited.—Capital £6,000. Dealers in metals and minerals, etc. Permanent directors: W. H. and H. B. Cooper. Registered office: 176 Brady Street, Bethnal Green, E.1.

A. N. Baird & Company, Limited.—Capital £20,000 in £1 shares. Iron manufacturers. Directors: A. N. Baird, R. Austin, junr., and J. Austin. Registered office: 62, Robertson Street, Glasgow.

Shenton & Company, Limited.—Capital £4,000 in £1 shares (1,000 preference and 3,000 ordinary). Engineers, etc. Directors: A. Handley and C. J. Margerison. Registered office: 68-9, Shoe Lane, E.C.

Shropshire Electrical & General Engineering Company, Limited.—Capital £500 in £1 shares. Directors: E. Townson and A. Taverner. Secretary: A. Taverner. Registered office: Grove Bridge Works, Ludlow, Shropshire.

Sherwood Hunter, Limited.—Capital £20,000 in £1 shares, to take over the business of a contracting engineer formerly carried on by Sherwood Hunter at the Malt House, Newlyn, Penzance, Cornwall. Registered office: Meadow Studios, Newlyn, Penzance.

E. Neale & Sons, Limited.—Capital £16,100 in 16,000 cumulative 8 per cent. preference shares of £1, and 2,000 ordinary shares of 1s. each. Lead merchants. Directors: E. J. Neale, W. Neale, and F. R. Smith. Registered office: 116, St. Mary Street, Southampton.

Gazette.

A WINDING-UP ORDER has been made against the Metal Smelters, Limited, Amberley House, Norfolk Street, London, W.C.

THE WILSON-WOLF ENGINEERING COMPANY, LIMITED, are being wound up voluntarily, with Mr. R. S. Dawson, Tanfield Buildings, Hustlergate, Bradford, as liquidator.

A MEETING of the creditors of Reid Bros., Engineers, Limited, will be held at the Institute of Chartered Accountants, Moorgate Place, London, E.C.2, on January 31

MR. W. J. D. PARSONS, Guildhall Buildings, Navigation Street, Birmingham, mechanical engineer and machinery merchant, is paying a first dividend of 3s. 6d. in the £.

Personal.

THE LATE MR. J. N. BARNARD, consulting engineer to Boulton & Paul, Limited, left £10,713.

THE LATE MR. R. KILBURN, senior partner of Richard Kilburn & Sons, engineers, Perseverance Works, Leeds, left £33,305, the net personalty being £23,938.

THE LATE MR. S. YOUNG, of Head, Wrightson & Company, Limited, Teesdale Ironworks, Thornaby-on-Tees, left £10,329.

THE LATE MR. A. LOCK, of J. Morton, Son & Lock, iron-founders and iron and steel merchants, Louth, Lincs., left £4,109.

THE LATE MR. F. L. NEWMAN, formerly of Newman, Hender & Company, brass founders, Nailsworth, now the United Brassfounders and Engineers, Limited, left £8,209.

THE LATE MR. F. G. HART, a member of the Institution of Electrical Engineers, for many years associated with Messrs. Peto and Radford, accumulator manufacturers, of Queen Victoria Street, E.C., left £19,168.

MR. M. B. U. DEWAR, manufacturing director of the Leeds Forge Company, Limited, has been elected managing director of the Metropolitan Carriage, Wagon and Finance Company, Limited, but will retain his seat on the board of the Leeds Forge Company.

MR. DAVID E. ROBERTS, who is the president-elect of the South Wales Institute of Engineers, is a specialist in iron and steel making, and since settling at Cardiff as a consultant engineer has been called in by important firms not only in this country but in U.S.A. and on the European Continent. In addition to being associated with the design and construction of iron and steel works, his services have been sought in connection with valuations, management of estates, arbitrations, etc. He is a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, and of other technical societies.

Telegrams: "THROWER, GLASGOW." Telephone: 5909 CENTRAL.

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IRON AND STEEL MARKETS.

Pig-iron.

Trade in the pig-iron industry opens out but slowly, notwithstanding the efforts made by the ironmasters to encourage consumption, and with the recent substantial cuts in values it can hardly be attributed to a holding-off policy on the part of buyers in the hope of still easier terms. In many cases prices have reached rock bottom. In the Cleveland area makers declare that No. 3 at 90s. represents an actual loss on the basis of present costs, and it is a question as to how long they can go on in such conditions. Everything depends upon an increase in the output, and this at the moment looks like being a very gradual process. As regards the home foundries, there is but little business coming out at present, and it is of a purely hand-to-mouth character. Trade with Scotland has certainly shown some improvement, but it is still almost negligible compared with the pre-war volume of business, which used to run to fully 1,000 tons a day. Inquiry for export is better, but this is rather for special iron than for the standard quality. It may be that prices will have to fall still further before a real revival begins, but that time is not yet. Two more furnaces are reported to be going in on No. 3, but the bulk of the output of these will not come on the market. On the whole, there is evidence of a steady, if disappointingly slow, forward movement. Furnaces are gradually coming back into commission, and there is reason to hope that by the end of the first quarter of the year solid progress towards a return to normal will have been achieved in the Cleveland pig-iron trade. Quotations are unchanged as follows:—No. 1, 95s.; No. 3 G.M.B., 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 82s. 6d. There is a free market for mottled and white iron, which are negotiable round about 80s. per ton.

In Scotland the founders are all short of work and the consumption of pig-iron is, in consequence, at a very low ebb. Unlike the reports coming from some other districts, it cannot be said that there is any sign of improvement here, and there is no suggestion of increasing the pig-iron production; at the moment a reduction in make is more likely. With stocks on hand and iron still to come forward, there is very little fresh buying being done. No. 3 Middlesbrough is being quoted to-day at £5 at Falkirk, and as No. 3 Continental is being quoted almost as high as this f.o.b. Antwerp, there is no chance of business in the latter.

In regard to hematite, it would be misleading to say that any important volume of business is on offer at the present moment, but there are not wanting signs that users are busying themselves with plans for future operation, and it would seem to be quite probable that the spring may witness a definite, though not a large, revival in trade.

Scrap.

Generally speaking, the demand for scrap of all kinds is still very poor, but apparently the fall in prices has come to an end, or nearly so. There are still some kinds which might be cheaper, and probably will be before the end of the year, but there is not much room for further reductions. The buying of scrap will improve as soon as the market for new materials becomes more active, and dealers will have to wait as patiently as possible for this time. The foundries of the country are generally short of work, and are not very good buyers of cast scrap at present, but the prices are well maintained so far as the better qualities are concerned. If it be true that the slump in pig-iron prices is over there seems no good reason for offering cast scrap at lower prices; for this would not result in any larger consumption.

In Cleveland the following are quotations for principal descriptions, all delivered works:—Heavy steel scrap, 60s.; steel turnings, 40s. to 41s.; cast-iron borings, 40s.; cast-iron machinery scrap, 80s.; bushelling scrap, 60s.; heavy forge iron, 75s. to 80s.

Heavy steel scrap to the usual steelworks specification is obtainable in South Wales in large quantities at 65s. to 70s., but transactions are few and far between. Heavy steel turnings have a quiet but steady demand at 52s. 6d. to 57s. 6d. Bundled steel scrap and shearings at 50s. to 65s., according to the methods adopted in bundling, have become quiet, and little business has been done.

Finished Iron.

In regard to finished iron, another week has gone without any official announcement of an alteration in the price of crown bars, but really an Association price of £13 will soon become ludicrous. There is plenty of good crown iron to be had for not more than £12, and it is time the Association dropped the ostrich policy and amended the price accordingly. It is doubtful if anyone is misled by the maintenance of this fictitious value on paper. There is very little trade in crown bars, however, and the few mills that are running cannot be kept fully occupied on them. As far as commoner iron is concerned it is reported that one prominent firm has "taken the bull by the horns" and cut in at 5s. under the Lancashire price. There are quite a number of makers, however, who declare complete indifference to business at the prices now obtainable, and declare their intention to keep their works standing for as many months as are necessary to let business get back on to profitable lines. Gas strip is even more hopeless than bars at the nominal price ruling. Marked bars have not altered, demand being rather quiet.

Steel.

In finished steel there is very little to be done at present, but a further decline in prices is expected this week. The official prices are unchanged, but the Welsh works are still accepting orders at prices which will not be considered in the Midland districts. The fact is that many of the Midland manufacturers are not at all anxious to do business even at the official prices, for they maintain that the more they do the more they lose. Of course, the remedy for this is to get the costs down, for one doubts whether the official prices can be maintained, and certainly they cannot, if business is to expand.

In Wales business is stagnant. At the moment there are no signs of improvement from any quarter, and the hopes of a continued revival have been shattered. The tone is weak, and makers are considering the advisability of closing down rather than continue taking orders at the unremunerative price now obtainable.

Tinplates.

Inquiries for tinplates are few, buyers holding off all they can in anticipation of still lower prices. Makers are not easy to deal with, however, and we do not think there is much doubt about it when they say that current prices are lower than the cost of production. Several mills have not yet restarted after the Christmas holidays, and many of those now running will be compelled to cease operations unless matters quickly improve, as, of course, they cannot go on making for stock indefinitely, and orders are running out. 19s. 3d. is about the ruling price to-day for spot lots of prime coke tins, net cash, f.o.b. Wales, a moderate business being reported, but for February/March delivery transactions have taken place at 19s.

Metals.

Copper.—Conditions in standard have been poor. Electrolytic continues extremely quiet, consumers both in England and France buying but little, and finding considerable competition among sellers for those orders which they have placed. In America producers are showing some willingness to sell at a price which they refused to accept previously. Consumers in that country, after being out of the market for some weeks, are sending in inquiries. Closing prices:—Cash: Wednesday, £65; Thursday, £64 17s. 6d.; Friday, £64 10s.; Monday, £64 10s.; Tuesday, £64. Three months: Wednesday, £65 15s.; Thursday, £65 12s. 6d.; Friday, £65 7s. 6d.; Monday, £65 5s.; Tuesday, £64 15s.

Tin.—The fall in tin values has been rather a disappointment to dealers after the optimistic tone just recently prevailing. In this country conditions are very unsatisfactory to the dealers, and not only are consumers buying little, but there are indications that for want of orders several of the tinplate works in South Wales may have to close down again before the end of February. Closing prices:—Cash: Wednesday, £156; Thursday, £155 15s.; Friday, £157; Monday, £157 10s.; Tuesday, £159 10s. Three months: Wednesday, £157 15s.; Thursday, £157 10s.; Friday, £158 15s.; Monday, £159 5s.; Tuesday, £161 5s.

Spelter.—The market has been dull and colourless, with values showing a downward tendency. Demand from consumers has relaxed both here and on the Continent, but, on the other hand, production is so curtailed that there is little or no surplus metal weighing on the market. Closing prices:—Ordinary brands: Wednesday, £25 10s.; Thursday, £25 12s. 6d.; Friday, £25 15s.; Monday, £25 17s. 6d.; Tuesday, £25 2s. 6d.

Lead.—Prices on this market have fluctuated slightly, but no material change either way has taken place. Arrivals have been larger, but the demand still continues to be poor. English closing prices: Wednesday, £24 10s.; Thursday, £24 10s.; Friday, £24 10s.; Monday, £24 10s.; Tuesday, £24.